The Province of Alberta

PETROLEUM AND NATURAL GAS CONSERVATION BOARD

Application for Permission to Remove or cause to be removed Natural Gas from the Province of Alberta, under the Provisions of the Gas Resources Preservation Act by Western Pipe Lines.

I. N. McKinnon Esq., Chairman

D. P. Goodall Esq.

Dr. G. W. Govier

Session: September 25th, 1950.

Volume 1.

I N D E X

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19th June, 1950.

25th September, 1950.

W I T N E S S E S

E X H I B I T S

PROVINCE OF ALBERTA

Before the

PETROLEUM AND NATURAL GAS CONSERVATION BOARD

Application by Western Pipe Lines for permission to remove or cause to be removed Natural Gas from the Province of Alberta, under the provisions of The Gas Resources Preservation Act.

Hearings on the above application before I. N. McKinnon, Esq., Chairman, and D. P. Goodall, Esq., at the Court House, Calgary, on the 19th day of June, A.D. 1950.

APPEARANCES:

C. E. SMITH, Esq., K. C.,	Counsel for the Board.
R. MARTLAND, Esq., K. C.	For Western Pipe Lines.
L. H. FENERTY, ESQ., K. C.	For the City of Calgary.
H. G. NOLAN, Esq., K. C.	For Northwest Natural Gas Co.
D. P. McDONALD, Esq., K. C.	For Westcoast Transmission Co.
G. H. STEER, Esq., K. C.,	For Canadian Western Natural Gas Co. Ltd.
B. C. WHITTAKER, Esq.,	For Prairie Pipe Lines Ltd.
J. C. MAHAFFY, Esq., K. C.	For Alberta Inter-Field Gas Lines Ltd.

THE CHAIRMAN: You have an application, Mr. Martland?

MR. MARTLAND: Yes, sir. If it may please the Board, after receipt of the Board's instructions with respect to notice I gave instructions to the advertising firm of Scoville & Wood Limited, of Edmonton, regarding the requested publications, and I have here the statutory declaration of Mr. David G. Wood of that firm. I do not know whether you want

it read or should I just tender it.

THE CHAIRMAN: We will mark that as Exhibit 1.

AFFIDAVIT PUT IN AND
MARKED EXHIBIT 1.

MR. C. E. SMITH: I have already seen it, sir, if that helps at all.

MR. MARTLAND: In brief, it establishes publication in the daily newspapers in three consecutive issues between the dates of May 1st and June 4th, and with respect to the weekly newspapers as between the same dates in two consecutive issues, with certain explanatory material. For example, in the Gleichen Call they only had one issue. It was published in that. In La Survivance in Edmonton they only published it once instead of the twice, through inadvertence. In regard to the Canadian Social Crediter they were not accepting advertising and returned the notice and did not publish it.

MR. SMITH: There is a list attached?

MR. MARTLAND: Yes. As exhibits there is a list of the various publications and a copy of the form of notice which was used. Then I have, sir, but I doubt whether they will be necessary, but they are here available, the statutory declarations from some person employed by each of those various publications establishing the publication in the individual newspapers. I have a bundle of those here and I can file them if you think it is necessary.

THE CHAIRMAN: I think we have been taking all those, sir.

MR. MARTLAND: All right, sir, I will tender those too.

THE CHAIRMAN: They will be Exhibit 1A.

BUNDLE OF STATUTORY DECLARATIONS PUT IN AND MARKED EXHIBIT 1A.

THE CHAIRMAN: That is the necessary proof.

MR. MARTLAND: I suppose I ask for an adjournment now formally until the 25th of September, sir?

THE CHAIRMAN: Which we will grant.

(The hearing was then adjourned until September 25th, 1950 at 9.30 A.M.)

ooOOOoo

9.30 A.M.
SEPTEMBER 25th, 1950.

THE CHAIRMAN: Are there any other persons who wish to register as interested parties in connection with this application of Western Pipe Lines?

MR. D. P. McLAWS: I wish to register as representing Prairie and Pacific Northwest Pipe Lines.

MR. J. E. A. MACLEOD, K.C.: I am representing the Union of California and McColl-Frontenac on this Application.

THE CHAIRMAN: The Board has a suggestion to make in regard to the sittings. We propose that we do not sit on Fridays from now on; that we have our usual sittings on Monday, Tuesday and Wednesday, that is from 9.30 to 1, and on Thursdays we sit from 9.30 to 12.30 and from 2 to 4.30. If anybody has any objection will they let us know?

Gentlemen, the Board has received three letters which I propose to read. These letters all have a bearing on the applications which the Board has before it relating to the removal of gas from the Province.

The first letter is a letter from Mr. Martland, representing Western Pipe Lines, and it is dated August 29th, addressed to the Chairman of the Board.

"Dear Sir:

The writer acts on behalf of Western Pipe Lines which has been represented at the hearing before the Board of the applications of West Coast Transmission Company Limited and North West Natural Gas Company.

We are somewhat concerned over the amount of time which has been devoted to the presentation and cross-examination of evidence dealing with pipe line routes,

"design and cost. While we realize that the Board requires such evidence, nonetheless the Board of Transport Commissioners must authorize the route and construction of any inter-provincial pipe line. It seems to us, therefore, that the proper place for a detailed examination of these matters is before the Board of Transport Commissioners. Moreover, if gas is to be exported out of Canada, the Dominion Government, through the Department of Trade and Commerce, will have to grant a permit authorizing such export.

We would respectfully suggest that it would be in the interest of all applicants and of the Board to curtail the presentation and the cross-examination of evidence on routes, pipe line design and cost. We would also recommend that the Board, after hearing all pertinent evidence, might determine the existence or otherwise of an exportable surplus of natural gas and, if there should be a surplus, determine, with the approval of the Government of Alberta, the conditions and provisoes necessary to protect the interests of the people of Alberta and of Canada. The choice of the pipe line route should, in our respectful submission, be left to the Board of Transport Commissioners.

The Petroleum and Natural Gas Conservation Board and the Provincial Government, having thus determined the conditions under which an export permit might be issued, could let it be known that such a permit would issue after the Board of Transport Commissioners had approved the route and the Department of Trade and Commerce had authorized export of natural gas, if outside of Canada.

" We would also respectfully suggest that, for the reasons outlined above, the Board might consider the desirability, with respect to its further proceedings, of conducting a joint hearing, in respect of all applicants before it, with regard to the question of the existence or otherwise of an exportable surplus of natural gas. Our idea is that all further evidence of any of the applicants in connection with this issue might be adduced at the one hearing, together with any other evidence on that point which any interested party might wish to present or which the Board might consider it desirable to hear.

We would respectfully request the Board's permission to submit an application on behalf of Western Pipe Lines to the Board, covering both of the above points, when the hearings resume on September 25th.

We are sending a copy of this letter to the Honourable N. E. Tanner, Minister of Mines and Minerals.

Yours very truly,

MILNER STEER DYDE POIRIER MARTLAND & LAYTON

RM:MZ Per: 'R. Martland' "

We will mark that as an exhibit.

DOCUMENT IN QUESTION
NOW MARKED EXHIBIT 2.

The second letter is one from the Western Canada Petroleum Association, dated September 20th, 1950. It reads:

"Dear Sir:

At a recent meeting, the directors of this Association adopted unanimously the following resolution:

'That the Petroleum and Natural Gas Conservation

" 'Board be requested to come to a decision at the earliest possible date as to whether the gas requirements of Alberta and the reserves of the Province are such as to warrant the export of natural gas; and that in order to expedite such decision, they confine their enquiries for the present to these questions only.'

In submitting this resolution, the directors wish to make it clear that they are in no way suggesting that the Conservation Board is to be criticized for the procedure adopted in the hearings up to date. They realize that the procedure followed was that desired by most of the applicants, whose views were entitled to consideration.

However, recent developments have in the opinion of the directors, made it essential that the preliminary question as to the availability in Alberta of gas for export, be determined as soon as possible, leaving all other questions for later determination.

Respectfully yours,

"G. W. Auxier"

G. W. Auxier
Executive Vice President "

GWA:O

DOCUMENT IN QUESTION IS NOW MARKED EXHIBIT 3.

The third letter is a letter from the Minister of Mines and Minerals, dated September 23rd, and addressed to the Chairman of the Board.

"Dear Mr. McKinnon:

The attached letter from the Right Honourable C. D. Howe is self-explanatory.

" Owing to the urgency expressed therein, I have been directed by the Executive Council to ask that your Board do all possible to facilitate your hearings so as to determine the amount of proven reserves of deliverable natural gas within the Province and the forseeable needs of the Province for domestic and industrial use; and, further, to advise as to whether or not and to what extent there is a surplus which might be available for sale outside the Province.

I have advised Mr. Howe of this action and explained to him the policy of this Government as expressed by Premier Manning on several occasions, and particularly as expressed by him in his Budget Address this year, which is as follows:

'The Government's first and foremost responsibility is to protect the interest and welfare of the people of this Province, and we are determined to carry out this responsibility to the best of our ability. To this end, no application for the export of natural gas will be given favourable consideration until such time as the Government is satisfied beyond question that under sound conservation and proration practices there are sufficient gas reserves to meet the present and future domestic and industrial requirements of this Province. When fully satisfied that this surplus exists over and above these requirements, sufficient to justify export under sound conservation and proration practices, the Government will approve the export of such surplus, with each application being considered on its own merits and in the light of all prevailing circumstances. Furthermore,

"'it will be a condition of any export permit that Canadian requirements must be given first priority.'

Taking into consideration the prevailing circumstances, we shall appreciate being advised of your findings at an early date, so that we might advise Mr. Howe accordingly.

Yours very truly,

'N. E. Tanner'

N. E. Tanner,
Minister. "

DOCUMENT NOW MARKED
EXHIBIT 4.

Mr. Howe's letter reads as follows:

"COPY

Ottawa, Canada,
September 16th, 1950.

Dear Mr. Tanner:

I have recently been advised by the Chief of the International Programme of the United States Munitions Board that the Board is seriously concerned about the lack of fuel in the Pacific Northwest section of the United States, where the wartime industrial development, together with diversion of normal oil supplies to the Far East, has seriously accentuated the scarcity.

It is suggested that the availability of large supplies of natural gas in the Province of Alberta is one source from which the scarcity of fuel and power in the Pacific Northwest could be alleviated. I am asked the question whether these supplies can be made available.

The letter indicates that if the supplies are

"not available, immediate steps will be taken to supply the area from Texas sources of natural gas. You are aware that an application has recently been filed with the Federal Power Commission of the U. S. A. for permit for a pipeline from Texas to the Pacific Northwest.

This Government is in the position that we cannot answer the question until Alberta decides whether gas from that Province will be made available for export outside the Province. There would seem to be great urgency for a decision one way or another. I sincerely hope that it will be forthcoming shortly, as pressure from the Munitions Board will certainly be a decisive factor in authorizing the granting of the franchise from Texas.

I see little prospect of a line being built from Alberta to the Canadian Northwest unless that line can be extended from Vancouver southward to serve the Pacific Coast cities.

Your sincerely,

LETTER NOW
MARKED EXHIBIT 5.

(Sgd) C.D. Howe."

Gentlemen, there will be copies of these letters available within a very few minutes. The Board would like to hear the views of counsel and any other interested parties in regard to the matters brought up in the letters I have just read.

MR. FENERTY: May I ask the Board whether the Government and the Board have given any consideration to the effect of that letter? Just hearing it I interpret it as an intimation that there must be a priority for export, otherwise as a war measure the policy of the United States will be to

build a line from Texas. That, to me, is a clear intimation to the Board, or at least a suggestion, that there should be a priority for export of gas from Alberta. Has that been considered?

(Go to page 12.)

THE CHAIRMAN: We are not prepared to express any opinion on Mr. Howe's letter. We would like to hear the views of other people. We have not had time to consider it.

MR. FENERTY: Well, we are in something now.

THE CHAIRMAN: Gentlemen, if you so wish, we are prepared to rise for 10 or 15 minutes and these letters will be distributed and you will have an opportunity of studying them, if you want to speak on them.

MR. WHITTAKER: This is a very serious matter in the turn of events. Might not we have a little bit longer than that? Would it be possible to address you tomorrow morning on it. Only one letter has been distributed.

THE CHAIRMAN: Well, I would like to hear the views of other counsel.

MR. D.P. McDONALD: May I say this, the motion which we have already had notice of from Mr. Martland deals specifically with these particular points. I think if we adjourn 10 or 15 minutes and let Mr. Martland proceed with his motion, then I think we can debate the pros and cons of that motion.

THE CHAIRMAN: We have that in mind, Mr. McDonald. We thought the letters were all along the same line. If any of the counsel feel that they wish to have longer to study the letters, the Board is prepared to defer the discussion on the letters until tomorrow morning and ask Mr. Martland to proceed with his application.

MR. STEER: The letters, it seems to me, Mr. Chairman, are intended to bring about the speedy determination of the one question that is referred to in Mr. Martland's motion, and my suggestion is that if you proceed

and determine Mr. Martland's motion you have answered the questions raised in the letters.

MR. WHITTAKER: I quite strongly disagree with that. However, I will address myself to him when I speak to the motion. It seems to me they are entirely two separate matters.

THE CHAIRMAN: In view of the fact there was not sufficient notice given on the last letter, we will defer discussion until tomorrow morning and ask Mr. Martland to proceed with his case.

MR. MARTLAND: If it may please the Board, I am here today on behalf of Western Pipelines in connection with an application to remove natural gas from the Province of Alberta for export to the Provinces of Saskatchewan and Manitoba, and from there to certain points in the States of North Dakota and Minnesota. Western Piplines was incorporated by a special Act of the Dominion Parliament on April 30th, 1949. The president of that company is Colonel L.D.M. Baxter of Winnipeg, immediate past president of the Dominion Command of the Canadian Legion, and Colonel Baxter will be present, we anticipate, on Wednesday to make a general statement similar in pattern to those which have been made to this Board in each of the earlier applications, and for that reason my opening remarks can be correspondingly brief.

With Colonel Baxter as a Board of Directors is a group of Winnipeg business men. This company would propose to carry gas generally along the lines of the C.P.R. main line commencing at a point in the vicinity of Pincher Creek, or in the event of there being a gas grid within the Province, then to connect with that gas grid

following the route of the C.P.R. main line and serving enroute Swift Current, Moose Jaw, Regina, Brandon and Portage la Prairie and into Winnipeg. It is proposed that there be a branch line north from Chaplin, Saskatchewan, to serve Saskatoon and Prince Alberta. It is proposed that there should be a branch line from Winnipeg to serve Selkirk and Pine Falls, and that the gas for delivery to the United States would be carried to the American border at Emerson and from there to serve certain points in North Dakota and Minnesota and in particular, municipalities along the Mesaba iron range. This scheme would provide natural gas for people in two western Canadian provinces, and with those preliminary remarks I might say also, Sir, that from the point of view of financing, there are in association with this company three Canadian investment houses, Osler, Hammond and Nanton of Winnipeg, Nesbitt Thomson and Company of Montreal, and Wood-Gundy and Company of Toronto.

The work so far done in connection with the engineering has been carried on by the firm of Stone and Webster Surveys Corporation of New York City, and there has been consultation with the Montreal firm of Donald Ross and Company and with Mr. Julian Garrett of Edmonton. The geological studies have been carried on by Petroleum Consultants of Houston, Texas, and we have with us from that firm Mr. J.O. Lewis and Mr. David Hawthorn, both of whom will be called. They have had the assistance of Dr. J.O.G. Sanderson of Calgary, who will also be called. Their report, gentlemen, is contained in one document which will now be submitted as an exhibit.

It is proposed that all three of these gentlemen read parts of it, the first portion up to the general conclusions to be presented by Mr. Lewis,

the second portion by Mr. Hawthorn, the supplementary portion by Dr. Sanderson. And I would make the suggestion to the Board, if it meets the Board's convenience, that perhaps the direct evidence of each of these gentlemen might be given in sequence so that the report would go in as a whole and the cross-examination then take place after the entire document has been read. I will now call Mr. Lewis. I tender this as an exhibit now.

BRIEF PREPARED BY MESSRS. LEWIS, HAWTHORN AND DR. SANDERSON PUT IN AND MARKED EXHIBIT 6.

MR. D.P. McDONALD: Is it Mr. Martland's intention to proceed with his motion tomorrow morning along with the letters that have been read by the Board? Is he abandoning the motion?

MR. MARTLAND: Oh, entirely not. It was the desire of the Board that it go over until tomorrow morning.

JAMES O. LEWIS, having been first duly sworn, examined by Mr. Martland, testified as follows:

Q Mr. Lewis, would you mind telling the Board your name and residence and outline your qualifications, please?

A My name is James O. Lewis, and I am a resident of Houston, Texas. I am a member of the firm of Petroleum Consultants, and I have been engaged in the consulting business in Houston for the past ten years. I am engaged in petroleum and gas geology and in the engineering phases of both petroleum and gas.

I am a graduate of the University of Stanford, California, in geology.

From 1909 to 1914 I was a field geologist in the oil regions of California, Texas and Montana and spent one summer along the border between Canada and Montana in 1914.

My business is estimating oil and gas reserves, valuing oil and gas properties, and I have also in past years engaged in estimating market demands of communities and making the preliminary surveys and estimates for gas pipelines.

From 1914 to 1921 I was in the United States Bureau of Mines. My first year with the Bureau of Mines was spent generally with the Indian Bureau at Muskogee, Oklahoma. My work there was with the conservation of gas, which was being flagrantly wasted at that time. The second two years with the Bureau of Mines was spent in investigating methods of increasing oil recoveries and estimating gas and oil reserves. The fourth year was spent in handling the experimental station of the United States Bureau of Mines at Bartlesville, Oklahoma. The last two years with the Bureau of Mines I was Chief Petroleum Technologist in charge of all oil and gas work for the Bureau. During my six years with the Bureau of Mines I wrote a number of bulletins and technical publications which were published by the Bureau. I left the United States Bureau of Mines late in 1920 and entered the firm of Smith and Dunn, which later became Dunn and Lewis of Tulsa, Oklahoma. The firm engaged in managing oil properties, in installing methods for increasing oil recovery, and specializing particularly in injection of air and gas for repressure purposes.

I also did much consulting work during that period on both oil and gas properties. The firm was dissolved in 1940, and I then moved to Houston, Texas, and set up a consulting office individually. A few years later I was associated with Mr. Hawthorn, who will follow me on the stand, and Mr. E.O. Bennett, in the firm of Petroleum Consultants. I have estimated reserves and engaged in various technical problems in oil and gas in nearly every State in the Union, and also engaged in work in oil and gas in South America and other foreign countries.

I have appeared before various regulatory bodies and commissions, and I have done work for the United States Helium Board and made special investigations for the United States Senate, for the Bureau of Internal Revenue, for the Security Exchange Commission and for various State organizations including the Conservation Board of the State of Kansas. I have appeared before the Federal Power Commission at a number of Hearings both for applicants and for interveners.

Q Mr. Lewis, your firm, Petroleum Consultants, prepared this presentation which has now been marked as Exhibit 6 in this Hearing?

A That is correct.

Q And that submission generally breaks down into four sections, the first being a general discussion with conclusions; second, with estimated gas reserves in Alberta; the third section dealing with deliverability; and finally, a supplement consisting of a discussion of the prospects of future discoveries. That is correct, isn't it?

A That is correct, yes.

Q And you will be dealing with the first portion, namely, the general discussions and conclusions?

A That is right, Mr. Martland.

Q Now, would you mind commencing to read the submission, Mr. Lewis.

A This report is entitled:

AN ANALYSIS OF THE NATURAL GAS RESERVES

AND DELIVERABILITIES

in the

PROVINCE OF ALBERTA

by

James O. Lewis David G. Hawthorn

Petroleum Consultants

Houston, Texas

In behalf of Western Pipe Lines and its application to the Petroleum and Natural Gas Conservation Board for permission to construct pipe line facilities and transport gas from Alberta to various municipalities in Saskatchewan, Manitoba and northern Minnesota for domestic and industrial consumption, we respectfully submit this report to the honorable members of the Board. We trust the observations and conclusions presented herein may be helpful to the Board in solving the many difficult problems relating to the exportation of gas now pending the Board's decision.

INTRODUCTION

For the past several months we have carefully studied the natural gas reserves of the Province of Alberta and their relationship to the question of maintaining an ample supply of gas to meet present and long term future requirements of the Province, while, if possible, at the same time supplying a major gas transmission pipe line to export gas out of the Province to serve market demands in other areas.

We have been ably assisted by Dr. J.O.G. Sanderson and Mr. Ian M. Cook, both of Calgary, Alberta. Mr. Floyd K. Beach has also been very helpful and to these gentlemen, as well as many others, we extend our expression of thanks and appreciation.

Our study has emphasized the need for clarification of certain phases of the problem of gas exportation and, hence, we have elected to approach the subject from a somewhat different point of view than has been done heretofore. During the past two years many competent geologists, engineers and men in the oil and gas industry have testified before the Dinning Commission, and this Petroleum and Natural Gas Conservation Board on Alberta's gas reserves and the future requirements of the Province.

Dr. G. S. Hume and Mr. A. Ignatieff's report and first supplement on Alberta gas reserves is a comprehensive treatise on the subject and has become a constant source of reference. Many of the witnesses, including ourselves, have drawn heavily on the findings of these two men. It is understood that a second

revision or supplement to the original work is now in preparation and it no doubt will be an added contribution to the present knowledge of Alberta's gas reserves.

Q By the way at that point, Mr. Lewis, that is now published, we understand, that is correct?

A We received that just a few days before this report was rendered.

Q Yes?

A Mr. G. E. S. Liesemer, chief engineer for the Conservation Board has done much work on the estimation of gas reserves, particularly his detailing of Medicine Hat and Viking-Kinsella. He is definitely an authority on these areas as well as gas reserves throughout the Province.

Mr. W. C. Spooner of Shreveport, Louisiana, presented to the Dinning Commission a detailed report on his estimation of Alberta gas reserves. Dr. T.A. Link, Dr. Hugh H. Beach, Dr. A. D.Brokaw, Dr. John F. Dodge, Messrs. Floyd K. Beach, Robert Pot, J.D. Weir and many others testified before the Dimning Commission. As the Dinning Commission reports, "There was marked unanimity of opinion in the evidence of the geologists with respect to the existing and proven reserves of gas in the Province. The methods of estimating the reserves adopted by Hume and Ignatieff in their report of April, 1948, were closely followed by the other geologists, and, therefore, Hune's report has served as a basis of comparison in respect to all the submissions received."

More recently available are the reports to this Petroleum and Natural Gas Conservation Board by Dr. A. W Nauss and Dr. S.E.Slipper; the first in behalf of Westcoast Transmission Company, Limited, and the latter in behalf of Northwest Natural Gas Company. Both companies have filed application for permission to transport gas from Alberta to the west coast of Canada and the northwest part of the United States. Dr. Nauss' report is a detailed study and presentation on Alberta gas reserves and Dr. Slipper's report is an excellent treatise on the geology of Alberta as it applies to the present known and future potential gas reserves of the Province.

Our review of the several reports that have been submitted to this Board and our own studies have led us to segregate the gas reserves so far discovered in Alberta, into three main categories:

(1) Those now committed to Alberta markets;

(2) Those which for one reason or another would not be attractive for export;

(3) Those which would be attractive and which, presumably, could be made available for export.

The first category includes the old fields of Bow Island, Medicine Hat, Foremost, Turner Valley and Viking-Kinsella and the new fields of Leduc and Jumping Pound. With the exception of Jumping Pound these fields supply enough information to provide

reliable estimates of gas reserves. There is substantial agreement between the several estimates submitted to this Board om these proved fields. We have checked the estimates and the data and we believe a full detailed study on our part would also result in our substantial agreement.

The second category of gas reserves includes isolated wells and small fields, or fields remotely located to which it would not be economical to extend pipe lines, although some may become important upon further exploration. It also includes gas reserves associated with oil production, which for this reason would not be attractive for export. We have not attempted to make detailed studies of such reserves, but have provisionally accepted the work of Hume, Nauss and others.

The third category includes the other fields which presumably can be made available for export. Because there has existed no market for the gas, virtually none of these fields have been adequately explored and the reserves are mostly in the probable and even possible classifications. We have studied these fields to the extent that obtainable information permitted.

For convenience of the Commission, we have further segregated known reserves into geographical groups to show their adaptability to the several proposed export lines, as well as the additional wells that would be required to meet deliverability requirements.

We have been impressed by the large gas reserves so far discovered by so few wells, and we have particularly concerned ourselves with studies of the latent possibilities of the Province. We have had Mr. Floyd K. Beach compile the information concerning the exploratory wells drilled in the Province and we have had Dr. J.O.G.Sanderson analyze the geological conditions affecting the possibilities of the existence of undiscovered reserves. Having witnessed the exploration and building up of proved reserves in other regions, we attach much more importance to the potentialities of such a region with respect to the future needs of Alberta than to what reserves the few wells have so far discovered. However, having participated in the initiation of a number of large gas lines, we are fully cognizant of the need for proof of enough deliverable gas for long enough to enable a pipe line to be financed, and we have carefully considered this phase of the situation.

GENERAL DISCUSSION

Like all other geologists who have studied the prospects for gas in the Province of Alberta, we are greatly impressed by the quantities of gas that have been discovered by the few wells that so far have been drilled in so large an area. The geologically promising area of Alberta approximates the geologically promising area of Texas, but in Alberta a total of only 2,914 wells, representing 11,778,700 feet of hole

had been drilled up to the first of 1950, whereas, 273,453 wells had been drilled in Texas. In the first six months of 1950, 7,964 wells, representing 34,360,000 feet of hole, 20% of which was wildcat footage, were drilled in Texas and despite the great number of wells that had been drilled in past years, new reserves are still being discovered at a faster rate than older reserves are being depleted. In 1949, the gas production in Texas was 3,519 MMMCF, over half of which went into interstate transmissiom lines.

The comparison with Texas shows the incipient stage of development and exploration so far reached in Alberta. A total of some 9,000 billion cubic feet of gas - there is a ccorrection there. It has 9,000 million cubic feet of gas in the text, it should be 9,000 billion cubic feet of gas - including past production has been discovered by the 2,914 wells, most of which were drilled for oil. There can be no doubt that the reserves so far discovered are but a minor fraction of those that will be discovered in the future. However, it cannot be expected that they will ever be as large as the Texas reserves as the formations underlying Alberta do not have as much gas capacity per square mile as in Texas. On the other hand, the prospective markets for Alberta gas are much less than for Texas gas.

The trends of drilling and discoveries in Alberta are shown graphically in Figures A and B.

Q I wonder, Mr. Lewis, if at that point you would turn

back now to those figures and just explain briefly the nature of those curves shown there, and explain what is indicated by them?

MR.C. E. SMITH: Before he does that, will you give us that correction again Mr. Lewis just made?

MR.MARTLAND: It should be 9,000 billion instead of 9,000 million.

A Change the "m" to "b".

MR.C. E. SMITH : It sounds better when you change million to billion. It means something.

Q MR.MARTLAND: All right, Mr. Lewis, will you explain the figures A and B?

A The object of Figures A and B was to trace graphically the trends of well drilling and the discoveries of gas reserves rather than to set forth exact figures. On Figure A entitled "Annual and Cumulative Record of Wells Drilled in Alberta, Canada", the top curve entitled "Cumulative Wells" shows the total of wells each year from 1924 and at the first of 1950 it represents a total amount of 2,914 wells.

Q That is all types of wells, Mr. Lewis?

A Yes.

Q Yes?

A This data was compiled by Mr. Beach from official records of the Commission. At the top of the graph it shows the discoveries of more important oil and gas fields of the Province. The curve at the bottom in dashed lines is the wells drilled annually, and the notable feature is that beginning in 1946 the very great increase in the rate of drilling wells within

the Province which was stimulated by the discovery of the Devonian oil in the Leduc Field.

Figure B is a graph entitled "Comparison of Annual and Cumulative Gas Discovery Wells Drilled in Alberta, Canada, and Cumulative Gas Reserve Trend."

Q Talking about Figure B now, are you, Mr. Lewis?

A Yes.

Q Yes?

A This differentiates from the previous figure in that the wells are limited to discovery wells, whereas the other figure related to all wells. The upper curve of accumulated discovery wells is from figures compiled by Mr. Beach and it shows a marked increase in rate of discovery beginning about 1944 or 1943. The bottom curve in dashed lines is the annual well discoveries which shows the increase in discovery rates beginning about 1944 or 1945. The middle curve was compiled, not by Mr. Beach but from various sources, including Spooner and others for early years and other data for the recent years, and it shows by the little cross mark quantities of gas that have been proved up by various years without any deductions for gas which has been withdrawn from these reserves. The dashed line drawn through there is to show the trend, and it does not exactly bisect the point. It also shows the tremendous increase, the acceleration in discoveries, not only in the number of discoveries but in the total gas reserves of recent years beginning about 1944 or 1945, and it can be seen that under this accelerated rate it is evident how rapidly reserves

could pile up and geologically, apparently, that is possible. And taking into account the great activity of search for oil, it seems very probable that there will be this rapid rise in trends in both numbers of discoveries and in total reserves discovered.

Q If you would resume your text then, Mr. Lewis, at the bottom of Page 6.

A Yes. Figure A shows the acceleration of drilling since the war and the acceleration of gas and oil field discoveries that resulted therefrom are shown at the top of the graph. Figure A should be compared with Figure B. Since 1944, the total number of wells drilled, the total gas discoveries, and the total of gas reserves discovered have each doubled. It has long been recognized in the United States that discoveries are approximately in proportion to drilling activities. The foregoing shows that Alberta can be expected to follow the same general trend.

Within this report is an analysis of the portions of Alberta that are promising for gas and oil discoveries. This analysis has been made at our request by Dr. J. O. G.Sanderson, independent geologist of Calgary.

Dr. Sanderson's analysis of the geological possibilities of Alberta for gas and oil reserves shows briefly the essential evidence and reasoning from which we agree with other geologists that Alberta is in the early stages of exploration and that the prospective gas resources of the Province are very large. The faith that experienced oil companies have in the

opinion of their geologists on the potentialities of the Province is evidenced by the millions of dollars being invested in the Province. Even though their interests are primarily in oil, their search for oil will also lead inevitably to the discovery of large gas reserves. Though no one can reliably forecast when, where or in what amounts gas reserves will be discovered each year, the general results can safely be relied upon and in that sense are not speculative. It must not be overlooked that the billions of dollars invested in the United States in all branches of the oil business and of its consumers including pipe lines, refineries, marketing organizations, automotive cars and factories are predicated upon the finding of new oil supplies each year. At no time has the oil industry ever had proved reserves in sight sufficient to meet more than fifteen years' consumption at the previous year's consumption rate. Were new discoveries not made, the daily productive capacities of the fields would decline to less than daily consumption in less than half of that time.

(Go to page 29).

CONCLUSIONS

The following statements are derived as a result of the studies we have made, and in substance they constitute a summary of our principal conclusions.

1. The gas reserves which have now been discovered and proved or partially proved by development demonstrate that the Province of Alberta is a major gas producing area. Exploration of the area is still at an early stage and discoveries which will, without question, greatly overshadow the present known reserves.

2. The large favorable area of Alberta has been sparsely tested by wells. Both from geological studies and from comparisons of the exploration histories of older areas of like promise, it is certain that the reserves so far found are only a minor fraction of the total that will be found by future exploration.

3. Only those fields which have had markets for gas have been developed and produced to the extent that their productive areas have been delimited and their gas reserves proved. Due to lack of incentive, the other fields have not been adequately tested and the reserve estimates are largely in the probable class. Segregation between proved and probable is a question on which there can be much difference of opinion, as there are no precise and invariable standards. Hence, most estimators have chosen to combine "proved" and "probable" and make no attempt to separate them. We have found it desirable to do the same.

4. We estimate that the sum of the proved and probable gas reserves of the Province approximates 5-1/2 trillion cubic feet. I would like to state at this point that since this was given to the printer, we acquired some additional information

and that there will be some minor changes made by Mr. Hawthorn. They will not be of any importance. About 2-3/4 trillion cubic feet of this is either owned outright or committed to local gas distributing companies serving the various municipalities of Alberta. A small portion of this 2-3/4 trillion cubic feet is in the probable class and under option rather than contract. It constitutes, however, the bulk of the proved gas reserves of the Province. Nearly 1/2 trillion cubic feet more can be considered not available by reason of its geographic location or being available only to a limited extent because of its association with the production of oil. The remaining 2-1/3 trillion cubic feet are the reserves which presumably can be made available for new markets.

Q MR. MARTLAND: Pausing for one moment there, Mr. Lewis, I am going back to the first line of that paragraph. Would it be correct if I said that the figure of 5-1/2 trillion cubic feet represents proved and probable marketable gas reserves?

A That is correct. That is what that was intended to be.

Q And in the last sentence in number 4, the 2-1/3 trillion should be changed to 2-1/4?

A Yes, sir.

Q Thank you.

A I will make the same correction wherever I read the figure in the later paragraphs.

MR. SMITH: That is just a matter of mathematics, is it?

MR. MARTLAND: Yes, as far as I could do it myself.

MR. SMITH: I agree.

A 5. This 2-1/4 trillion cubic feet of gas is scattered from the southern boundary of the Province to roughly 50 miles north of Edmonton, and from the eastern boundary of the Province to the Foothills. A comprehensive gathering system would be required to make it all available to pipe line. The gas reserves supplying local markets are unevenly distributed among the various cities of the Province. An intra-provincial gathering system could have the advantage of relieving this inequality, in addition to more evenly distributing all markets to the producers.

6. Of the 2-1/4 trillion cubic feet of gas reserves available for export, probably not more than one-half can be considered to be proved at this time and the fields will require systematic drilling to provide the information needed to prove all the reserves. Still more drilling will be required to provide adequate deliverability.

7. We doubt whether the operators will risk drilling the necessary wells until assured of a waiting market. Until an export permit is granted, it would appear that such assurance cannot be given. We believe that when an export permit is granted, that arrangements will be made to have the fields tested adequately. Furthermore, we believe that when the probable gas reserves now in sight are tested, there will be enough proved gas reserve to support an export pipe line without infringing on reserves committed to local markets. In the meantime discoveries will be made which will further support both local and export requirements.

8. Only 60% to 90% of the free gas reserves originally found in the fields will be residue gas available for pipe

lines. From 5% to 20% of the original gas reserves cannot be economically recovered and must be left in the ground. Of the produced gas, from 5% to 25% will be consumed or lost in field operations, or be extracted as condensates, sulphur or carbon dioxide. The percentage of the gas reserves that ultimately can be marketed to pipe lines will be smallest in the Foothill fields and greatest in the Cretaceous fields of the Plains. The average for the Province should approximate 85%.

9. A more important question to an export line is the percentage of gas that can be economically recovered during the life of the mortgage bonds which finance a large pipe line. Assuming a twenty year bond issue, which is usual in the United States, we believe that on the average, 70% of the gas reserves could be recovered within twenty years. The quantity available to a pipe line would be further reduced by the shrinkage of the gas from extraction of liquids and impurities and from field uses as stated above.

10. An important factor in supplying the future demands, particularly within Alberta, will be the gas necessarily produced from oil wells that must be given first access to markets. This casing head gas production is not yet of much importance, but for reasons stated in the body of this report, it will grow much faster than oil production and it may be expected to become a major source of supply that will last for many years.

Q MR. MARTLAND: Just on that point, Mr. Lewis, I wonder if you would mind expanding on that point a little further and explaining the problem that you visualize as

arising from the further development of oil fields and oil production?

A For two reasons there will be a very marked increase in gas from oil fields. One of them is the activity in the search for oil fields and the strong probability that other fields in the Devonian of the character so far found will be found in future at an apparently rapid rate, judging from the results of searches made in recent years. The other is that almost invariably in large oil fields the gas/oil ratio, that is the quantity of gas which must necessarily be produced with each barrel of oil, is increased as the field gets older. There may be a few fields which have an active water drive and no initial gas cap, where this increase will not be the same. Such fields as Redwater, but there will be other fields which have no active water drive or only a limited water drive and there will be other fields like Leduc that will have large gas caps. In limestone fields of this character the experience has been that as wells get older the gas/oil ratios go up very markedly. I have in mind one field with which I am quite familiar in Texas where the initial gas/oil ratio was in the order, in my recollection, of a 1200 cubic feet, quite high. But the gas/oil ratio is already up to 6000 cubic feet and the calculations are that we expect it to go to 30,000 cubic feet. So that in the production of oil, as the years go by, there must necessarily be an increase in the quantity of gas which will be produced, except in those few cases where the gas is reinjected back into the field, that is for reasons of increasing recovery, and this gas will be pressing on the market and must be disposed of in some way day by day or it will otherwise have to be wasted in the air as gas was wasted

for many years in Turner Valley. There will also be fields in the Foothills belt like Turner Valley and like Pincher Creek and Jumping Pound - although Pincher Creek and Jumping Pound do not have oil reserves, the nature of the fields and economics require that those fields be produced at quite a constant rate. They cannot be subjected to fluctuations in demand which are characteristic of the markets in this Province where your load factors are often very low. That is, Pincher Creek for example, it is likely that there will be from 100 to 120 million cubic feet of gas, residue gas, available. That is going to require a tremendous investment in wells and in facilities for treating the gas, extracting the sulphur and preparing the gas for market. Economically it is not feasible to fluctuate such an investment from a low of possibly, oh, 30 or 40 million feet a day to a high of 200 million feet a day, to accommodate itself to the natural demands of the Province. So that there is going to be, as time goes on, a constant building up of supplies of gas which are going to be pressing for disposition. As I see it, the only solution is really a matter of storage. Otherwise it will be wasted gas. It will certainly not be feasible to shut oil fields in to accommodate themselves to the gas market.

Q Would you regard that problem as likely to become progressively more serious, Mr. Lewis?

A Yes, it will become more and more serious as time goes on, as new oil fields are found and the oil fields get older.

Q The only choices with respect to this gas produced in that fashion are to find markets or to provide storage or to allow it to go to waste?

A That is the only solution I know.

MR. SMITH: Is that serious for new applicants to have that available gas? What do you mean by "serious"? What did you mean in your question by that situation becoming serious?

MR. MARTLAND: I was speaking from the point of view of the Province and the gas reserves, the problem of wastage and the problem of conservation. I will make that as clear as I can.

Q As you visualize it, Mr. Lewis, there will be more and more of this gas being produced in connection with oil production as time goes on?

A In my opinion that is true. In my opinion it is likely to be a larger and larger percentage of the gas seeking markets. Gas of that kind will be steadily produced from day to day. You have got to use it at the time or provide storage facilities. And it has got to be produced with reasonable uniformity.

Q Yes, and with reference to this particular applicant, Western Pipe Lines, have you given any thought to the possibilities of storage on account of that situation?

A Yes. This became obvious when we considered the situation here, that it would be necessary to provide storage for Pincher Creek and such other fields of that character I have mentioned that may be drawn upon for supplies for this line. We have not made a detailed study of the storage possibilities of the Province, but we are informed there has been storage conducted at Bow Island. We know enough about the character of the Cretaceous sands, particularly those in the Benton-Colorado formation, to know that they are promising storage reserves. I might mention that I have had occasion to make studies of

storage of gas, the storage problem in Michigan and elsewhere for some years past. We also take into consideration the possibilities of finding storage closer to the market and with respect to Western Pipe Lines we have made a brief review of the literature of Manitoba to see what promise there might be, and while we are not in a position to say that storage can be successfully worked out there, the information which we have gotten from the public records indicates that about 50 miles west of Winnipeg the geological conditions are reasonably favourable for the finding of storage facilities. It is not likely to find actual gas fields there but it is probable to find sands which are sealed in in such a manner by structural conditions that they can be made into storage fields. It is possible to take a sand which is water-filled initially, and displace the water and make a gas storage project out of it. However, to definitely find out whether this can be done satisfactorily would require a great deal of investigation and once you decided on the locality it would take some time to displace the water and prepare the sand for storage.

Q Then would you carry on with the text again, please?

A 11. In contrast to the attitude on the exportation of gas, we have observed no disposition within the Province to restrict the production or exportation of oil. The encouragement of oil exportation can be expected to cause rapid search for and development of oil production and with the oil, much gas will be found and developed. Much gas will necessarily be produced with the oil and must be disposed of as produced. This companion gas will become of increasing importance and in our opinion, the Province should reserve an adequate place

for it in any plans for the future marketing of gas.

12. The gas reserves now committed to market within Alberta are in excess of 30 years requirements, based on an estimated demand in 1960 of 78 billion cubic feet. In view of the evidence on the potentialities of the Province, it would appear that the Province can safely rely upon future discoveries for their more distant needs. Moreover, Alberta is exceptionally well protected by other fuel resources, chief among them being coal, oil and tar sands. According to the Royal Commission, Alberta has a recoverable coal reserve of 23,937,150,000 tons, which alone is equivalent to some 480 trillion cubic feet of natural gas.

Respectfully submitted,

PETROLEUM CONSULTANTS,

By "James O. Lewis"
James O. Lewis

By "David G. Hawthorn"
David G. Hawthorn

Q Then just referring to that number 12 item you have just read, Mr. Lewis, when you compare the tonnage of coal to so many trillion cubic feet of natural gas, that is a conversion merely with reference to the cubic content - -

A The fuel equivalent.

Q And the 78 billion cubic feet of gas that you refer to at the beginning in paragraph 12 as the estimated demand in 1960, that figure was taken from where?

A That is taken from the submittal by the local Gas Company.

Q That is the exhibit that was submitted in the Westcoast Transmission hearing?

A I do not remember just when and where it was exhibited, or submitted. It is from a report which I understand is in evidence.

Q You saw that exhibit which was submitted to the Board in another hearing?

A Yes.

Q The reference to the Royal Commission in that paragraph, as I understand it is the report of the Royal Commission, the Dominion Royal Commission on coal sometimes known as the Carroll Report?

A I obtained this figure from Dr. Sanderson and I understand that is the source of his information.

Q Just one or two other things, Mr. Lewis. Would you care to expand just a little your views with regard to the effect of market incentive on the discovery of further proved gas reserves?

A A large part of my life has been spent in the conservation and the storage of gas, beginning in 1914 when I was sent down to Muskogee, to see what could then be done about the terrific waste of gas which was going on. I soon came to the conclusion that the source of the trouble was inadequate markets for the gas and inadequate prices. This gas was being wasted because it either came with the oil or it interfered with the drilling of oil wells and they were deliberately blowing away the gas from the upper sands, which could not be controlled by the methods of drilling which were in vogue at that time. That is the old cable tool method. Since that time it has been more and more impressed on me that wherever and whenever there is lacking an adequate market for gas that you have waste. It becomes almost uncontrollable on the one hand, and on the other hand that the operators avoid the reporting of gas. I know of

many cases where the operators in the drilling of a wild cat well have deliberately concealed the appearance of gas, or not taken the steps necessary to test out the sands to find out whether they contain gas or not, because there is no value in it to them and to test out the gas would cost them money, and might even result in their having to complete wells in the sands and let them stand there for years without any income. On the other hand, whenever the incentive has been provided for gas by adequate markets and adequate prices there is an immediate interest on the part of operators to explore for and develop gas. The conservation of gas in the West in my early experience was very marketdly different in Oklahoma where there was no adequate market for gas and in the Eastern fields where the price of the gas at the well ranged from 15 cents to 25 cents per thousand cubic feet. In those Eastern fields they were producing wells, whole fields where the wells would produce as little as 10,000 cubic feet of gas a day, which was ridiculously small from the standpoint of the Western fields. If an operator does discover gas under conditions of inadequate market demands he is likely to let his well stay there and hope for his market to develop. He will have no reason to go out and drill additional wells that are necessary to outline a field and to provide evidence from which reliable estimates of reserves can be made. The result would be if there is the incentive, and there is some place to go with the gas at a profit, you will doubtless have continued discovery within the Province resulting from the search for oil, but it will just pile up and accumulate more and more the probable and possible reserves. Individual wells here and there, none of them plowed out. While that is very promising, I do not believe a large project like any of

these long distance pipe lines can be financed with that evidence. It requires further evidence before the bankers will supply the money necessary to build a line of this character.

Q Thanks very much, Mr. Lewis. Would it be satisfactory if Mr. Lewis returns afterwards for cross-examination, sir?

THE CHAIRMAN: Yes.

MR. FENERTY: Just one thing. I do not want to cross-examine Mr. Lewis now on the general submission, but there were a couple of questions I would like to ask him before that motion is argued tomorrow. That is the only thing, just on one point. I think it would be very relevant to that motion.

THE CHAIRMAN: How long will it take you to present the rest of the evidence before cross-examination? Have you any idea?

MR. MARTLAND: Just the length of time to read it, sir. It is a matter of estimating the reading time.

MR. FENERTY: I will not be more than three minutes.

MR. C. E. SMITH: I will give you even money on that.

MR. FENERTY: I always have two minutes leeway on that.

THE CHAIRMAN: I think there will be time after this is read.

MR. FENERTY: As long as it is before the motion.

MR. STEER: Mr. Chairman, I have a remark to make that might be pertinent to what my friend says. If he

wants to examine Mr. Lewis with respect to the motion, I had hoped - I do not want my wishes to influence too much anybody else's conduct, but I had hoped to get back to Edmonton this afternoon. I have now read again Mr. Howe's letter and the important sentence in that letter seems to me to be this: "There would seem to be great urgency for a decision one way or another." And that seems to be what is emphasized in Mr. Martland's motion and in Mr. Tanner's communication to the Board. I am making this remark for the purpose of asking the Board and my friends if they will not consider again dealing with Mr. Martland's motion some time today. I do suggest respectfully that there is nothing in Mr. Howe's letter that alters in any way the motion which Mr. Martland is proposing to make.

MR. NOLAN: If I may add a word to what Mr. Steer has said,so far as I am concerned I do not intend to discuss the correspondence between Mr. Howe and Mr. Tanner or between Mr. Tanner and the Board. My only purpose was to try and make some useful suggestions as to the manner in which the hearings might be accelerated. I am quite prepared to do that at any time that meets the convenience of the Board and counsel.

MR. FENERTY: I am quite pleased to argue that motion today if I am allowed to ask these several questions within the next three minutes. I will guarantee to stop at 11 o'clock whether there is an answer or not, that is, if we get started.

THE CHAIRMAN: Has anybody any objection now you have read these letters to go ahead with the discussion of the motion of Mr. Martland, of the points raised in those

letters?

MR. WHITTAKER: Following the reading of these letters I understood this was going to be argued tomorrow morning and I am in the process of endeavouring to receive some instructions, but I would not like to argue the motion until I have had that opportunity, and whether I will have that later this morning or this afternoon I do not know, sir. But if I do not receive that I would prefer to argue it tomorrow morning. I have no objection to any other counsel, if they would like to argue it today, but I hope to have the privilege of speaking to it tomorrow morning, if I may, unless I get my instructions before that time.

THE CHAIRMAN: I feel that it would be better to have all of the argument at the one time, if possible, and for that reason we will go on with it tomorrow.

MR. STEER: Very good, sir.

THE CHAIRMAN: I think, Mr. Fenerty, you might ask those questions when we have finished with the reading of this brief.

MR. FENERTY: Just whenever you say.

THE CHAIRMAN: I think this would be an appropriate time to adjourn.

(At this stage there was a short adjournment.)

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DAVID G. HAWTHORN, having been first duly sworn, examined by Mr. Martland, testified as follows:

Q You are a partner of the last witness, Mr. Lewis, in the firm of Petroleum Consultants?

A That is right.

Q And would you just state briefly to the Board your qualifications, please.

A My name is David G. Hawthorn. My residence and place of business is Houston, Texas.

I attended the University of Colorado in 1921 through 1924, received the degree of Bachelor of Science in Mechanical Engineering. In 1928 I received my Graduate degree entitled Degree Mechanical Engineering. Through the years 1924 through to 1928 I was employed in the geological and petroleum engineering and production department of the Marlene Oil Company of Ponca City, Oklahoma. From the years 1929 to 1934 I was associated in the petroleum engineering department of Barslow Oil Company working with a gentleman you all know very well by the name of Mr. W.K. Whiteford, who is now president of British American Oil Company. From 1935 to 1942 I was in the petroleum engineering department of the Amerado Petroleum Corporation of Tulsa, Oklahoma. From 1942-1943 I was with the Petroleum Administration for War in Washington. In 1944 we formed our partnership, Petroleum Consultants, of Houston, Texas, and as has been said by Mr. Lewis, the three partners of that firm are James O. Lewis, Mr. E.O. Bennett and myself, and are in the business of oil and gas and geological and petroleum consulting.

Q And you have testified previously before the Federal Power Commission, Mr. Hawthorn?

A Over the past three years I have testified before the Federal Power Commission in the case of Tennessee Gas Transmission Company, Texas Eastern, Transcontinental Natural Gas Pipeline Company, Texas-Illinois and Piedmont Gas Company.

Q And you are now to present the portions of this report marked 1 and 2. Would you mind commencing the reading of that on page 14?

A Part 1 of our report to the Board, entitled:

ESTIMATED GAS RESERVES IN ALBERTA

This is an analysis of gas reserves estimated to be recoverable and marketable from the several oil and gas fields in the Province of Alberta. The estimates are not exclusively our own but are combinations of our own work and the findings of several others. We have studied most of the gas reserves in the Province more or less in detail and while we may not have performed in all cases our own individual calculations we have developed opinions as to the relative magnitude and value of the different gas reserves. After considerable study of the gas reserves and the work and findings of other estimators we have attempted to set forth what seems to us to be a realistic determination of what the marketable gas reserves in Alberta mean in terms of proved and probable supply for meeting long term requirements of the Province, while at the same time being able to meet the demands of a large transmission line designed to export sizable quantities of gas out of the Province to other markets.

It is interesting and important to observe the geographic location of the reserves and in this connection we have separated the various reserve estimates into five different areas as follows:

Southern Alberta, which comprises the plains area to the south and southeast of Calgary and the Foothills area immediately west of Calgary, south to the international boundary;

Midway Area, comprising the plains area midway between Calgary and Edmonton in the vicinity of the towns of Stettler, Castor and Hanna;

Edmonton Area, which covers an area some 30 to 40 miles in radius with Edmonton as the center;

Eastern Alberta, which includes all the plains area immediately to the east of Edmonton extending to the Alberta-Saskatchewan border; and

Northern Alberta, including all the territory to the north and northwest, commencing with Athabaska and Lac La Biche to the Pouce Coupe and Peace River areas.

In the work we have done on the gas reserves in Alberta we have been guided by the classification and definition of reserves as follows:

As used in this report the term "proved" means that enough information and data are available to permit making estimates that are subject to only small errors, or minor difference of interpretation or opinion.

The term "probable" means that while there is a substantial amount of information and evidence available, it is nevertheless incomplete and the estimates are therefore

subject to much larger errors and much wider differences of interpretation and opinion.

There can be no precise definitions of the terms "proved" and "probable" in estimating reserves. In a strict sense the only thing proved about a reserve is that which can be obtained from wells drilled into the formation and reservoir. The evidence may be logs, formation samples or pressures and production records. Everything else must be surmised. However, engineers and geologists from long experience have developed judgment in classifying reserves depending on how reliable the basic data and estimates might be. Since matters of experience and judgment are involved two estimators given the same evidence may at times differ widely, particularly with respect to probable reserves.

Two methods are used in estimating free gas reserves, one based on geology of the reservoir and the other upon physical principles.

The first is the so-called "volumetric" method which involves two steps. The first step is to determine the space in the reservoir which might contain gas. This is accomplished by a study of the information obtained from the wells drilled, geological structure, the productive area, the average thickness, porosity, and connate water. The product of these factors gives the void space in the formation capable of holding gas. The next step is to compute the quantity of gas stored in the space under conditions of reservoir pressure and temperature and composition of the gas. The reliability of volumetric estimates depends

upon the quality and completeness of the data and upon the competence of the estimator. Though it might appear that a few samples of reservoir rock totalling only a minor fraction of the whole could not yield enough information for practical purposes, actual experience has shown that a comparatively few samples, coupled with experience and good judgment do provide data adequate for estimating reserves within small limits of error.

The other method used in estimating gas reserves is the "material balance" method. With sufficient information this method can be used in estimating either oil or gas reserves but the calculations for gas reserves are much the simpler. By knowing the loss in reservoir pressure from the start of a period to the end, the gas production for this period and the composition of the gas, the reserves can be computed.

Theoretically it is not necessary to know the area, thickness, porosity or connate water of the reservoir in order to estimate gas reserves by this method. Actually it is not safe to make estimates by this method without such additional evidence since the method has certain dangers and pitfalls. There may be, for instance, an active water drive which sustains reservoir pressures and if not taken into account would result in a serious over-estimation of reserves. Or the reservoir pressures at the points of observation, which are the wells, may be much less than exist elsewhere in the reservoir. For example, in large reservoirs that are not fully explored, or in tight formations, the observed reservoir pressure may be considerably less than the true

average pressure and calculated reserves would be underestimated. Finally, the pressure and production data may be inaccurate or insufficient.

In principle the methods are equally sound and the choice should be made in accordance with the best evidence that is available. When reliable evidence is available for both methods neither one should be relied upon to the exclusion of the other but one should be used to check the other. We do not distinguish between proved and probable on the basis of the method used but upon the weight of evidence that is available for making the estimations.

In further classifying and defining kinds of gas and gas reserves we have in this report used the conventional meaning of the terms "gas", "associated gas", and "dissolved gas".

"Gas", where unqualified, means gas which exists in reservoirs where no oil columns are present. "Associated gas" is defined as free gas that occurs in the structurally high portions of oil reservoirs, and is sometimes called "free gas", or "gas-cap gas". "Dissolved gas" is the gas which exists in solution with oil.

Associated gas and dissolved gas will constitute an increasingly important source of supply in the Province as more fields like Redwater and Leduc are discovered. The gas will be produced simultaneously with the production of oil. After being produced it will have to be used, returned to the reservoir, or wasted. If oil is produced the production of gas cannot be avoided. This gas should have first call on markets, and production from non-associated gas reserves

should be used to supply the rest of the needs. In the early stage of producing an oil reservoir, particularly where no gas caps exist, like Redwater, there will be little gas available for pipe line. The wells will be produced at solution ratios and most of the gas will be consumed in drilling and other field uses. As production continues, field uses become less and in nearly all cases the gas-oil ratios increase, particularly in gas cap reservoirs and in reservoirs where neither an actual water drive exists nor pressure maintenance is practiced. In types of reservoirs similar to those so far discovered in the Devonian at Leduc and Redwater, gas-oil ratios of several thousand cubic feet per barrel can be expected within a few years after production starts. Since this gas must necessarily be produced with the oil plans for the future of Alberta gas reserves should contain adequate provisions for its effective use.

Gas Reserves in Southern Alberta

Accompanying this discussion is a tabulation of gas reserves together with maps of the Pincher Creek and Jumping Pound Fields. There is also a map of the Pakowki Lake Area which shows the three important fields of Pendant d'Oreille, Foremost and Manyberries. The various reserve estimates shown in the tabulation have been separated and placed in four different groups as the Foremost Area, the Medicine Hat Area, the Princess-Patricia Area and the Foothills Area.

In general there is good agreement among the various reserve estimates in the six fields located in the Foremost Area. All of the fields are comparatively small with the exception of Pendant d'Oreille. To secure a figure for

estimated marketable gas reserves, we have conditionally accepted Hume's estimates, but have used Nauss' practice of applying a discount factor to recoverable reserves to allow for shrinkage and probable efficiency in recovery. We have studied the Pendant d'Oreille Field rather critically and are satisfied that the indicated gas reserves are as nearly correct as can be made with the available information. The gas reserves in this group may all be classed as proved.

In the Medicine Hat Area there is good agreement on the small reserves in Bow Island and Dunmore, but in the past there has been some disagreement on the estimate of reserves for the Medicine Hat Field. In September, 1948, Liesemer of the Petroleum and Natural Gas Conservation Board made an extensive study of Medicine Hat and after making four different computations recommended a reserve of 365 MMMCF. At that time Hume had a much lower estimate, but has since revised it upward. It is understood that Hume's latest figure is 342 MMMCF which is presumably gas in place. At any rate, Liesemer's figure of 365 MMMCF has been accepted with an allowance for gas consumed in the interim period. Due to the presence of the Medicine Hat sand over so large an area to the east of the town of Medicine Hat, together with several encouraging tests, Dr. S.E. Slipper has estimated a potential reserve of 636 MMMCF for the area. This would seem to indicate that the reserve figures which have been calculated for the Medicine Hat Field should be at least a conservative, if not a minimum, estimate. All of the estimated marketable gas reserves shown for this area can be considered proved.

In the Princess-Patricia Area we have been concerned over the lack of evidence that this area will deliver the amount of gas which heretofore has been estimated to be recoverable. The nature of the producing sections and the tests which have been made to date do not seem to be convincing evidence that the area will prove to be highly productive. For this reason we have made our own estimate of the gas reserves in the area and present a figure of 143 MMMCF for the combined Princess and Patricia Fields. Mr. Cook has done most of the detail work and we are indebted to him for his assistance in developing this reserve estimate. The reserve should be classed as estimated marketable proved and probable.

In the Foothills Area there are three fields, namely: Pincher Creek, Turner Valley and Jumping Pound.

We have been provided with a reserve estimate for Pincher Creek of 1,560 MMMCF of high pressure separator gas recoverable to a reservoir abandonment pressure of 400 psi.

Q Just at that point, Mr. Hawthorn. You say, "We have been provided with a reserve estimate". Can you tell me, Mr. Hawthorn, by whom it was provided?

A It was by the Canadian Gulf Company. Gulf Oil Company provided that information to us.

Q And provided the material on which the estimate was based?

A That is correct.

Q And I believe that material is already embodied in Mr. Slipper's report in Northwest Natural Gas' submission?

A That is right.

Q Thank you.

Shrinking this volume by twenty per cent to allow for the extraction of liquid hydrocarbons, the removal of hydrogen sulphide and carbon dioxide, the field use gives a marketable reserve of 1,248 MMMCF which must, at this stage of development of the field, be classed as proved and probable.

It has been estimated that the recoverable reserve at Turner Valley as of the first of 1950 was 251 MMMCF.

There has been considerable difference in the estimates of reserves for the Jumping Pound Field. With development of the field as it stands today, certainly any estimate of reserves should be classed as proved and probable. We have studied the field at some length and at this time are inclined to lean on the conservative side. We have, therefore, used Mr. Ralph E. Davis' figure of 401 MMMCF for marketable proved and probable reserves. This figure is based upon an estimated productive area of 5000 acres and an average effective sand thickness of 120 feet. Work which Mr. Cook has done on the area rather closely supports the estimates of Mr. Davis. Mr. Cook has used a productive area of 4875 acres and an average sand thickness of 110 feet. Hume obtains an estimated reserve of very nearly 50% more and virtually all the difference is in the estimated acre feet of producing formation, as he has used a productive area of 6300 acres and an average effective sand thickness of 147 feet.

Estimated marketable gas reserves for the entire area total 2,764 MMMCF, the larger portion of which must be classed as proved and probable due to the early stage of

development of Pincher Creek and Jumping Pound.

Gas not available for export is estimated to be 1,103 MMMCF of which 1,040 MMMCF is considered to be committed. The remaining 1,661 MMMCF is assumed to be available for pipe line. This constitutes the bulk of the gas reserve in the Province which is assumed to be available for export.

Q Does the Board wish to have these statements read in?

THE CHAIRMAN: No, I think we will take those as read.

RECOVERABLE GAS RESERVES (Southern Alberta) MMMCF

	Hume	Spooner	Nauss	Others		Petroleum Consultants Est. Gas Market-able Gas	Not Avail-able	Gas Avail-able for P.L.
Southeastern Plains								
Foremost Area								
Foremost	26	28.4	26	25.9 7	Weir Leisemer	21	(21)	-
Many-berries	31	49.5	29	49.5	Beach	26	-	26
Pendant d'Oreille	260	260	253	260	Beach	227	-	227
Black Butte	39.5	35.9	39	36	Beach	34	34	-
Smith Coulee	2	6	2	6	Beach	2	2	-
Calif. Standard	17	-	19	-		17	-	17
	375.5	379.8	368.0			327	57	270
Medicine Hat Area								
Medicine Hat	342[A]	415	259	265	Leisemer	350	(350)	
				21	Leisemer			
Bow Island	25.3	25.3	21	15	Davies	17	(17)	
Dunmore	24	25.1	23	25.1	Weir	18	18	
	391.3	365.4	303.0			385	385	

(Cont'd)

David G. Hawthorn - Dir. Ex.

RECOVERABLE GAS RESERVES (Southern Alberta) MMMCF (cont)

	Hume	Spooner	Nauss	Others		Petroleum Consultants Est. Marketable Gas	Gas Not Available	Gas Available for P.L.
Southeastern Plains								
Princess-Patricia Area								
Princess	362	296	280	271	Weir	143	-	143
Patricia	43.1	49.7	124	49.7	Weir	-	-	-
Brooks	11.3	11.6	11	5.6	Weir	9	9	-
				12	Leisemer			
	416.4	357.3	415.0			152	9	143
Foothills								
Pincher Creek	1583.6[A]	500	1788	-		1248	-	1248
Turner Valley	251.1	290	251	270	Connell	251	(251)	-
Jumping Pound	920.0	918	908	1053	Dodge	401	(401)	
				1201	Brokaw			
				401	Davis			
	2754.7	1708.0	2947.0			1900	652	1248
Grand Totals	3937.9	2910.5	4033.0			-2764	1103 (1040)	1661

( ) Committed Gas
A Gas in Place.

Gas Reserves in the Midway Area

In the Plains Area, midway between Calgary and Edmonton, are several fields for which gas reserves can be estimated. They are Stettler, Hanna, Castor, Provost and Oyen. With the exception of Provost the reserves are small and are committed to serving local communities. We have not studied the fields in any detail and have made no estimates of our own. We have provisionally accepted the work of Nauss on Stettler, Hanna, Castor and Oyen, and of Spooner, Pot and Nauss on Provost.

David G. Hawthorn - Dir. Ex.

Provost represents a marketable gas reserve of some 100 MMMCF, which is not believed to be committed and could be useful to a pipe line traversing the area. Pot has used a figure of 85 square miles for the estimated productive area of the field. Hume has considered an area of only 40 square miles for the productive area. This figure would seem to be fairly well proved by present wells, while Pot's 85 square miles would appear to extend out into what should be classed as probable area. Considering the nature of the Viking Sand and the manner in which it is found productive over wide areas, it would seem proper to be generous in drawing the estimated productive limits of the field. If this is done, however, the estimated reserve should be classed as proved and probable. This seems to us to be the most logical interpretation and explains our reason for using Pot and Nauss' figure.

The estimated marketable gas reserve total for the area is 216 MMMCF, of which 94 MMMCF is considered to be committed to local markets, 22 MMMCF to be otherwise unavailable and 100 MMMCF which might be made available for export.

(Go to page 55)

RECOVERABLE GAS RESERVES (Midway Calgary-Edmonton)
MMMCF

					Petroleum Consultants		
	Hume	Spooner	Nauss	Others	Est. Marketable Gas	Gas Not Available	Gas Available For P.L.
Stettler	-	-	60	-	36	(36)	-
Hanna	24.5	24.5	36	-	33	(33)	-
Castor	-	-	29	-	25	(25)	-
Provost	52	110	111	110 Pot	100	-	100
Oyen	-	-	27.4	-	22	22	-
	76.5	134.5	263.4		216	116	100
						(94)	

( ) Committed Gas

Gas Reserves in the Edmonton Area

Accompanying this discussion is a tabulation of reserves and a map of the area immediately north of Edmonton showing the several proved or probably productive areas of Morinville, Bon Accord, Picardville, Legal and Excelsior. The map is drawn to a small scale and is not intended to be accurate with respect to showing all the well locations or the productive outlines of the several areas. The different areas have been indicated by a light dashed line for the purpose of showing their relative positions. The general outline of the highly prolific Redwater oil field is also shown.

In considering the gas reserves of the area Nauss has referred to five or six named fields. We have considered these several areas around Morinville

collectively and refer to them as the Morinville Area. We have felt that the potentialities of the area for gas production are considerable and for this reason have studied it in some detail. We are indebted to Mr.Cook for most of the information on the area and for his assistance in helping us develop the figure of 450 MMMCF of marketable gas reserve which we choose to consider as a minimum estimate for the combined areas. Potentially the area is one of the most promising and could develop to ultimately show an aggregate reserve of several times this figure. Nauss has shown separate estimates for the different fields which collectively add up to more than twice this amount. He has classified the estimates as proved marketable gas. The area is extremely promising, but we felt that more evidence is needed to calculate reserves over so wide an area. We have chosen, therefore, to stay partly on the conservative side, while at the same time recognizing the very attractive potentialities of the area. The available evidence appears to warrant the opinion that a minimum of 150 MMMCF of gas reserve can be estimated for the Viking Sand in the area and 300 MMMCF for the Sunburst Zone, making the above mentioned total of 450 MMMCF.

The latest reserve estimate on Redwater by Hume shows gss in place in the amount of 96.1 MMMCF. This figure has been used as the estimate of marketable gas reserve, but it is classed as not available.

The Leduc-Woodbend field is not only one of

the three very prolific oil fields in Alberta, but it also constitutes the largest proved gas reserve in the Edmonton area. We have considered it to be committed and have not studied the field in detail. The figures developed by Nauss have been conditionally used, but it should be observed that the gas reserve is continually growing with the development and expansion of the oil producing area. Hume has just announced a figure of 1,261.4 MMMCF which presumably is considered by him to be gas in place. When this is reduced to marketable gas it would appear that the result would be larger than the figure of 617 MMMCF estimated by Nauss. If the gas reserves at Leduc have been recently extended by as much as Hume's figure indicates, it would seem apparent that our estimated marketable reserve for the area, as well as the total estimated marketable reserve for the Province, would be low by about 300 billion cubic feet. If this reasoning is correct, the estimated amount of dedicated and committed gas of 2,742 MMMCF would be low by the same amount, but the estimated amount of gas assumed to be available for pipe line would not be affected.

Since writing this we have secured the latest information on the Leduc-Woodbend Fields and if we will refer for the moment to the Table following page 26.....

Q MR.MARTLAND: I think you will have some changes to make on Page 26 itself, won't you, Mr. Hawthorn?

A That is right.

Q Would you just indicate to the Board what those changes are and then we will go on with the Table.

A Very well. We will read on and read Page 26. The total estimated marketable gas reserve for the area is 1,250.1 MMMCF, and I want to change that figure of 1,250.1 to 1,478.1, and that will read, the total estimated marketable gas reserve for the area is 1,478.1 MMMCF of which, and I want to change that figure of 760.1 MMMCF to 988.1 MMMCF, of which 988.1 MMMCF are considered to be not available, while 490 MMMCF are assumed to be available for pipe line and export.

Q Now, would you indicate the changes required on the Table immediately following page 26?

A Under the column Estimated Marketable Gas in Leduc-Woodbend, the figure of 617 changes to 845, and the figure following that in parenthesis of 617 also changes to 845. The total at the bottom of the page under Estimated Marketable, the figure of 1250.1 changes to 1478.1. The figure in the following column, the next column to the right, the figure of 760.1 changes to 988.1, and the figure under that of 617 in parenthesis changes to 845 in parenthesis. The following figure of 490 in the last column is not changed. These changes will be reflected again in the Summary tabulation which will be shown later.

RECOVERABLE GAS RESERVES (Edmonton Area) MMMCF

					Petroleum Consultants		
	Hume	Spoomer	Nauss	Others	Est. Marketable Gas	Gas Not Available	Gas Available For P.L.
Leduc-Woodbend	1261.4/	634.9	922.7	697.1	Pot 845	(845)	-
Redwater	96.1/	129	233	129	Pot 96.1	96.1	-
Morinville	244	-	872	-	450)	-	450)
Bon Accord	-	-	29	-	)	-	)
Picardville	-	-	25	-	)	-	)
Legal	-	-	65	-	)	-	)
Bailey Long Island	-	-	16	-	)	-	)
Golden Spike	25.0	-	50	-	25	15	10
Excelsior	-	-	73	-	62	32	30
	1626.5	763.9	2285.7		1478.1	988.1	490
						(845)	

( ) Committed gas

/ Gas in Place

Q Yes?

A On Page 27, Gas Reserves in Eastern Alberta, and I will read from the text again.

Gas Reserves in Eastern Alberta

The accompanying tabulation shows there are thirteen fields in the Eastern AAlberta area, for which gas can be estimated. With the exception of the Viking-Kinsella Field, which is one of the largest fields in the Province, all of the fields and gas reserves are shown to be small and are not of much consequence at this time.

The various estimates which have been made for the area are in close agreement. We have studied the area only to the extent of being familiar with it, and satisfied that if we made our own estimates of reserves they would not be greatly different than those which have been used. Furthermore, all of the reserves are believed to be committed to local markets or otherwise not available to pipe line.

TThe total estimated marketable gas adds up to a figure of 954 MMMCF, nearly all of which can be considered as proved. Out of this 954 MMMCF, 856 MMMCF are considered to be committed, while 98 MMMCF are considered to be not available for one reason or another.

I might just mention that out of that 856 MMMCF 842 of the committed gas reserves is the Viking-Kinsella gas reserves.

RECOVERABLE GAS RESERVES (Eastern Alberta Area)
MMMCF

	Petroleum Consultants						
	Hume	Spooner	Nauss	Others	Est. Marketable Gas	Gas Not Available	Gas Available For P.L.
Viking-Kinsella	994	971	994	971 Pot 805 Liesemer	842	(842)	-
Vermilion	9	10.3	4	-	3	(3)	-
Lloydminster	14.8	14.8	14	-	11	(11)	-
Wainwright	-	-	-	-	-	-	-
Battleview	18.4	18.4	34	-	30	30	-
Dina	-	-	3	-	2	2	-
Blackfoot	-	-	1	-	1	1	-
Elk Point	7.8	7.8	8	-	7	7	-

St. Paul	-	-	3	-	2	2	-
Ashmont	-	-	13	-	10	10	-
Ranfurly	-	-	36	-	32	32	-
Spedden	-	-	12	-	8	8	-
Edgerton	-	6.6	7	6.6 Weir	6	6	-
	1044.0	1028.9	1129.0		954	954	0
						(856)	

( ) Committed Gas.

Gas Reserves in Northern Alberta

In the area north of Edmonton from Athabaska and Lac La Biche northwest for some 250 to 300 miles to the Pouce Coupe and Peace River areas there are some seven scattered fields for which gas reserves can be estimated. While most of the fields and their combined reserves are small, the area nevertheless has large potentialities and some day will probably be a major source of gas and oil supplies for the Province.

All of the seven fields in the area, namely: Athabaska, Lac La Biche, Peace River, Pouce Coupe, Pelican, Boyle and Jarvie are assumed to be committed or are considered to be unavailable to pipe line because of their remote geographical locations. We have, therefore, not considered the area in any detail and have made no study of the individual fields. In order that a summary of reserves for the Province could be developed, we have provisionally accepted the figures presented by Nauss.

The estimated marketable gas reserves total 202 MMMCF, of which 135 MMMCF are considered to be committed to local markets and 67 MMMCF not available. None of the reserves are believed to be suitable for export at this time.

RECOVERABLE GAS RESERVES (Northern Alberta) MMMCF

						Petroleum Consultants	
	Hume	Spooner	Nauss	Others	Est. Marketable Gas	Gas Not Available	Gas Available For P.L.
Athabaska	16.4	16.3	16	-	4	(14)	-
Lac La Biche	-	-	25	-	22	22	-
Peace River	-	-	-	-	-	-	-
Pouce Coupe	41.0	-	135	-	121	(121)	-
Pelican	-	-	11	-	9	9	-
Boyle	-	-	6	-	5	5	-
Jarvie	-	-	39	-	31	31	-
	57.4	16.3	232		202	202	0
						(135)	

( ) Committed Gas.

SUMMARY OF RESERVE ESTIMATES

Cumulative reserve figures for the different areas in the Province and for the Province as a whole are given in the accompanying tabulation.

Hume's most recent estimate of total recoverable gas in Alberta is 6,364.0 MMMCF. All of this is calculated to an abandonment pressure of 100 psi and no allowances have been made for shrinkage or other losses. We have arrived at a total of 5,614.1 MMMCF of marketable gas in the Province. After considering

the several known differences in the two figures, it is felt that they are in reasonably close agreement.

Spooner's estimates are old and do not reflect the changes which have taken place over the past two or three years. Nauss' figure for proved recoverable gas reserves to 100 psi is large comparatively, but when reduced to marketable gas, his estimate is only a little more than 6 trillion cubic feet. The difference between his estimate and ours is readily accounted for by the difference in thinking for the reserves at Jumping Pound and Morinville.

Fairly good agreement is, therefore, indicated in all three estimates. We have knowingly been conservative in estimating the extent of some of the fields and probable reserves and our estimate is, therefore, lower than the rest by a modest percentage.

The estimated total marketable gas of 5,614.1 MMMCF are composed of 3,363.1 MMMCF of gas that are not available, of which 2,970 MMMCF are considered to be committed to Alberta markets, and an estimate of 2,251 MMMCF of gas that are assumed to be available for export.

Regardless of how these figures compare with other estimates, or how conservative they may be, they nevertheless show that:

(1) A large enough reserve of gas, which is mostly proved, is now committed to local Alberta markets to insure an adequate supply for many years to come; and

(2) Approximately 2-1/4 trillion cubic feet of proved and probable marketable gas reserves, most of which exist in the southern part of the Province, are estimated to be available for pipe line and export.

And in the Table which follows in the line under the Edmonton Area of the estimated marketable gas, the figure of 1250.1 changes to 1478.1.

Q MR. C. E. SMITH: What was that last again?

A 1478.1 instead of 1250.1. That is in the column under Estimated Marketable Gas, Edmonton Area.

Q MR.STEER: What is that figure again?

A 1478.1. The figure immediately to the right of there, 760.1 changes to 988.1, and the figure immediately below that of 617 in brackets, changes to 845 in brackets. That changes the totals at the bottom of those two columns. The first, Estimated Marketable Gas, the figure of 5386.1 changes to 5614.1, and the figure in the next column of 3135.1 changes to 3363.1, with the figure below that in brackets of 2742 changing to 2970 in brackets.

SUMMARY OF RECOVERABLE GAS RESERVE ESTIMATES (All Areas)
MMMCF

				Petroleum Consultants		
	Hume	Spooner	Nauss	Est. Marketable Gas	Gas Not Available	Gas Available For P.L.
Southern Alberta	3937.9	2910.5	4033	-2764	1103 (1040)	1661
Midway Area	76.5	134.5	263.4	216	116 (94)	100
Edmonton Area	1626.5	763.9	2285.7	1478.1	988.1 (845)	490
Eastern Alberta	1044	1028.9	1129	954	954 (856)	0
Northern Alberta	57.4	16.3	232	202	202 (135)	0
	6742.3/	4854.1	7943.1	5614.1	3363.1 (2970)	2251

( ) Committed Gas.

/ A part of this is gas in place - Est. Rec. gas as of June 30, 1950 by Hume is 6,364.9 MMMCF

Q MR. MARTLAND: These various estimates, Mr. Hawthorn, all relate to areas which you have classified as proved or proved and probable?

A That is right.

Q They fall within one or other of the classifications?

A Yes, that is right.

Q Would you care to say something briefly with regard to what has been called potential fields, that is, the possibilities of further development?

A Well, potential or possible reserves are in the speculative class and it is hazardous to develop concrete figures for possible or potential reserves. All one can do is to indicate the possible realm of

their magnitude, and as far as the potential reserves of the Province, I believe that Dr. Sanderson will cover that in great detail in his following remarks.

Q Certain areas fall only within the possible realm because of the lack of evidence to make an estimate sufficient, or lack of sufficient evidence to make an estimate which you could call probable or proved, is that true?

A That is right.

Q And would you care to say anything with regard to the effect of the impetus of the market in being able to acquire the necessary evidence to make some of those fields fall within the probable or proven group?

A Well, any remarks that I would have to make have been pretty carefully gone over by Mr. Lewis in his remarks that he just made on the incentive for progressing with discovery of exploratory and development drilling. It is just as essential that development drilling is continued as exploratory drilling which merely finds local spots of interest that we can estimate probable reserves for, but does not go far enough to develop the area to where sound and concrete estimates of proved reserves can be made.

Q Yes. Mr. Lewis referred in his experience to some instances where an operator might find gas and not wish even to disclose that he has found gas; is that similar to what you have observed, that is, where there is no market available for the gas which has been found?

A Oh, that is an experience over many years by many oil men that discoveries like that that cannot be put to good use are frequently, the information is frequently

concealed because there are certain obligations that may be made upon the operator if the information is brought to light.

Q And what is the effect on a field where there are wells of that type drilled and then abandoned, can you give us some information with regard to that situation?

A That brings up a feature in connection with the exploration of the Plains area of Alberta that has made quite an impression on myself. At the beginning of our study, we worked on maps to a considerable extent trying to show for our own information the areas that could be classed as proved. Those that were developed had enough wells in them that we could really estimate reserves for, wells spottimg the great number of locations that indicated shows of gas, and then likewise spotting those that had no shows whatsoever. And it is distinctly impressive to notice how many wells throughout the plains area have been drilled and have recorded shows and have been plugged or abandoned. Some of them, of course, have been kept in what is called the suspended class. From the mechanical point of view of exploring and developing and drilling wells, this is not a good practice. It is difficult to always plug wells so that salt water does not enter the producing formation and ruin the reservoirs, and to drill a large number of random wells over an area like has been done to the south and southeast of Calgary, and make no use of those wells, or not prepare them for future production, but to either abandon or temporarily abandon them is, to say the least, dangerous production practice in

the light of making those reserves useful for future purposes. There is a danger of the reservoirs being watered out and the reservoirs destroyed for future use. I bring that out because I think that it is somewhat of a hazardous practice to continue drilling a great many wells over the area and not make good use of them.

Q We now pass on, Mr. Hawthorn, to the next part of the Report, which has to do with deliverabilities. Could you just, before commencing to read that, tell the Board a little about your experience with regard to this question of computing deliverabilities, your own experience in that field?

A Well, I think if anything is to be said along that line it is in connection with the work that has gone on over the past two years, and what has transpired in connection with the study of deliverabilities for the Federal Power Commission. Approximately a year and a half ago the Federal Power Commission became concerned in a number of cases about the ability of the wells and fields to produce over long periods of time, the quantities of gas that were being set up as recoverable reserves supporting these large pipe lines. However, at this time it was precipitated by the question of showing more exactly the deliverability of the properties, and that was requested by the Federal Power Commission, and all submittals to the Federal Power Commission since that time have included rather a detailed study of the deliverabilities of the wells and the fields supporting pipe line projects.

Q And have you yourself made some study of the principles and methods used in computing deliverabilities?

A Yes, Mr. Lewis and myself were involved in the commencement of that work, and we had, at least we had our share, and we were a little instrumental in setting up a pattern of studies that have since gone forth in the work for the Federal Power Commission.

Q In that connection did you prepare a document for the Federal Power Commission?

A Yes.

Q Having to do with principles and methods?

A Yes, we prepared a little pamphlet entitled "Principles and Methods" - I have forgotten the exact title. Yes, it was "Principles and Methods used in Estimating Future Deliverabilities of Gas Wells."

MR.MARTLAND: If the Board pleases, Mr. Hawthorn has brought some copies with him. They are not in any way relevant with regard to Westcoast's particular case, but it may be of some particular interest.

MR. C. E. SMITH: Whose case, Westcoast's?

MR.MARTLAND: Western Pipe Lines. They are not directed to that case in itself, but it might be of some assistance or value to the Board as indicative of methods which have been used by the Federal Power Commission, and there are a number of copies available here, if it is desired to make use of them.

THE CHAIRMAN: Well, we just might mark it as an exhibit.

BOOKLET ENTITLED "PRINCIPLES AND METHODS USED IN ESTIMATING FUTURE DELIVERABILITIES OF GAS WELLS" MARKED EXHIBIT 7.

Q MR.MARTLAND: Would you go on from there, Mr. Hawthorn, please, with the text at page 31?

A

PART II

ESTIMATE OF DELIVERABILITIES

In considering the exportation of gas out of the Province of Alberta to other Canadian Provinces and possibly into northern parts of the United States we have assumed that the presentation of estimates showing the ability of dedicated gas reserves to deliver required supplies of gas would be desired by the Petroleum and Natural Gas Conservation Board. If deliveries are to be made in the United States, the same information will be needed for presentation to the Federal Power Commission, whose responsibility it is to regulate the movement of gas and other fuels.

We have, therefore, developed examples of deliverability projections for the Pincher Creek, Pendant d'Oreille and Manyberries Fields, which we introduce herewith for the purpose of illustrating the relationship between gas in place, reservoir pressure decline with depletion, open flow potentials and number of wells. Deliverability projections can be made for other fields in the Province, which might be available for pipe line, such as the Princess-Patricia, Provost, Morinville and others. Generally speaking so much of these reserves are in the probable class, so few wells have been completed and tested, and so little reliable information is available on the open flow capacity of the wells that such analyses would be largely hypothetical, and would probably not be representative of the actual conditions

that will exist after further development.

Deliverability analyses are for the purpose of indicating the rate at which wells, reservoirs or fields are likely to be able to produce over long periods of time, and, with the depletion of reserves, stay within certain legal and economic limits. The producing capacity of any gas property or field depends upon several factors, the principal ones being the size of the reserve, the reservoir pressure, the potentials of the wells and the number of wells. The Petroleum Division of the United States Bureau of Mines has done a great deal of work on the study of the open flow capacity of gas wells and its publication, called Monograph 7, entitled "Back Pressure Method for Measuring Gas Well Capacities", provides the basis for making deliverability projections. Experience gained in the past few years in operating gas-condensate cycling projects and thousands of gas wells producing daily into large intra and interstate gas transmission systems has supplied additional information to where reasonably accurate projections of the deliverability of gas properties can now be made. The accuracy of deliverability projections, of course, can be no better than the accuracy of the basic data that are available. Deliverability projections of this sort are not the same as and should not be confused with estimated schedules of "takes" from wells or properties, which may or may not have any relationship to the ability of the wells to delivery.

In making a preliminary estimate of the rate at which any gas reserve can deliver gas so as to properly serve a pipe line financed on twenty-year amortization bonds a reasonably accurate rule of thumb method is to divide the reserve by 10,000. In other words, there is generally an average of about

1 million cubic feet of delivery capacity per day that will last for fifteen to twenty years for each 10 billion cubic feet of gas in the ground. The factor which probably affects this ratio the most is the open flow capacity of the wells, which varies greatly between wells and properties. It should be observed that a ratio of 7300 to 1 would deplete a given gas reserve at a continuous and uniform rate in exactly twenty years. 7300 is the number of days in the twenty years. Some fields with large capacity wells and effective water drives can almost meet this condition while other fields with tight formations and low capacity wells would require a ratio of more than 10,000 to 1 unless a large number of wells were drilled, which might not be economical.

The general usefulness and accuracy of the 10,000 to 1 ratio may be observed in the accompanying deliverability projections. According to the present indicated average well potential and the estimated number of wells that will be drilled, Pincher Creek with 1,690 MMMCF of gas originally in place, and an ultimate of twenty-five wells can produce 150 MMCF per day for a period of fourteen years without exceeding 25% of open flow capacity. Pendant d'Oreille with 290 MMMCF initially in place and ultimately thirty wells can produce 30 MMCF per day for fifteen years. Manyberries with 34 MMMCF originally in place and eight wells can produce 4 MMCF per day for a period of eighteen years before reaching 25% of open flow capacity.

These capacities are well-head capacities which for pipe line purposes must be shrunk for liquid hydrocarbon extraction, the removal of hydrogen sulphide, carbon dioxide and other impurities, and field use.

Pincher Creek Field

This field is estimated to contain a large gas reserve which, if proved by further development, will require a comparatively large rate of production per day in order to deplete the reserve in a reasonable length of time. The gas has a high content of hydrogen sulphide and carbon dioxide, which must be removed before going to pipe line. A large and costly plant installation will be required to properly treat the gas. For greatest efficiency the plant should be operated uniformly at near full capacity. Production from the field should never be allowed to exceed the designed capacity of the plant as no untreated gas should be allowed to enter the pipe line. Production from the field may be some less than the designed capacity of the plant, but if it is too far below it will result in inefficient operation of the plant.

The capacity of the plant to be constructed could be the controlling factor in the deliverability of the field if the plant were to be too small. Conversely, well capacity and depletion of the reservoir would control deliverability if the plant were sufficiently large. It is obvious, therefore, that the capacity of the plant should be carefully planned and made as near optimum and compatible with the field as possible.

The capacity of the proposed plant has not been fixed to date and what action the operator of the field may take is unknown. It is our opinion, however, that if the estimated gas reserve of the field is proved to be right, the intake capacity of the proposed plant and a reasonable rate at which to operate the field would be in the neighborhood of 150 MMCF of raw gas per day. This is the figure which has been used in the accompanying deliverability forecast.

The estimated number of wells ultimately to be drilled and their average open flow capacity are required in making a deliverability analysis. The two wells so far completed at Pincher Creek had an open flow capacity of 45 and 83 MMCF per day or an average of 64 MMCF per day. As may be seen from the tabulation, this figure was used as the initial average open flow potential. Since it is based on only two wells, its limitations should be recognized. Further wells may be found to have less open flow capacity, but due to the results of acidizing the last well drilled it is believed more likely that much larger capacities can be secured in later wells. If this is true one of two things will result. Either fewer wells will be required to make the deliveries shown or the delivery capacity of the field will last longer before starting to decline.

The tabulation and graph show that ten wells are initially required to deliver 150 MMCF per day and stay within the legal allowable of twenty-five per cent of the open flow capacity. Additional wells will be needed as shown in order to meet the demand. It is estimated that twenty-five wells will be ultimately needed and can be economically drilled. This number of wells will provide the desired delivery of 150 MMCF per day for fourteen years before exceeding the legal allowable. After this time, the delivery capacity will decline as shown.

If the twenty-five per cent legal allowable is adhered to profits obtained from operation of the property will decline after the fourteenth year down to the break-even point. If the properties are abandoned at this time, there will be much recoverable gas left in the ground. This forced premature abandonment, because of uneconomic operation, would be the

result of strict adherence to twenty-five per cent legal allowable. This would be opposed to the principles of conservation. It may, therefore, be expected that when this time is reached restrictions on rates of withdrawal will be modified.

Q You might then explain the table which follows page 36, Mr. Hawthorn, without the necessity of reading in the various figures into the record.

A In this tabulation there are 13 columns of figures. Column 1 is merely the number of years. Column 2 is the amount of raw gas production that will be incurred by a constant rate of production over the years to the point where the 25% legal allowable is reached, which is shown in Column 10. After that the legal allowable in Column 10 is made to stay constant and the amount of gas that is withdrawn is whatever the total potential shown in Column 7 is the controlling factor. The figures in Columns 5, 6 and 7 will then control the amount of gas that will be produced during the years, holding the production of the wells at their 25% legal allowable. The other columns are of secondary interest and merely go to complete the record of the deliverability study.

Q Yes, and this study indicates the number of producing wells commencing in the initial year at 10 and gradually increasing up to a total of 25 wells in the 14th year?

A That is right.

Q Well please explain the graph which follows immediately after the table which you have just examined.

A This graph is called a graphical analysis of Gas Reserves and Deliverability. It is entitled that because it graphically analyzes and portrays not only the story of gas reserves but also the story as to the deliverability analysis and the figures

shown in the tabulation. In the ordinates plotted, first the ordinate at the left is gas delivery rate in million cubic feet per day and the abscissa, the horizontal at the bottom of the page, is years. Therefore, in technical explanation of the graph this is a time rate graph. Being a time rate graph the area under any line can be represented as gas volume. That is why I made this note. These areas represent gas volume.

(Go to page 78.)

DELIVERABILITY CALCULATIONS

PINCHER CREEK FIELD

1	2	3	4	5	6
Year	Yearly Raw Gas Production	Remaining Raw Gas @	Average Pressure psia @	Average Potential per Well @	Producing Wells
Initial		1,690,000	4,945	64.0	10
1	54,750	1,635,250	4,785	60.8	10
2	54,750	1,580,500	4,625	57.5	11
3	54,750	1,525,750	4,464	54.0	12
4	54,750	1,471,000	4,304	51.0	12
5	54,750	1,416,250	4,144	47.6	13
6	54,750	1,361,500	3,984	44.4	14
7	54,750	1,306,750	3,824	41.4	15
8	54,750	1,252,000	3,663	38.5	16
9	54,750	1,197,250	3,503	35.7	17
10	54,750	1,142,500	3,343	33.0	19
11	54,750	1,087,750	3,183	30.6	20
12	54,750	1,033,000	3,023	28.0	22
13	54,750	978,250	2,862	25.4	24
14	54,750	923,500	2,702	23.0	25
15	52,487	871,013	2,549	20.8	25
16	47,450	823,563	2,410	18.8	25
17	42,888	780,675	2,284	17.1	25
18	39,018	741,657	2,170	15.7	25
19	35,806	705,851	2,065	14.5	25
20	33,069	672,782	1,969	13.3	25

7	8	9	10	11	12	13
Total Potential @	Daily Raw Gas Production Total	Avg/Well	% of Pot.	Net Residue Gas Sales at 80% Daily	Yearly	Cumulative
640.0						
608.0	150.0	15.0	22.7	120.0	43,800	43,800
623.5	150.0	13.6	24.7	120.0	43,800	87,600
648.0	150.0	12.5	24.1	120.0	43,800	131,400
612.0	150.0	12.5	23.1	120.0	43,800	175,200
618.8	150.0	11.5	24.5	120.0	43,800	219,000
621.6	150.0	10.7	24.2	120.0	43,800	262,800
621.0	150.0	10.0	24.1	120.0	43,800	306,600
616.0	150.0	9.4	24.1	120.0	43,800	350,400
606.9	150.0	8.8	24.3	120.0	43,800	394,200
627.0	150.0	7.9	24.7	120.0	43,800	438,000
612.0	150.0	7.5	23.9	120.0	43,800	481,800
616.0	150.0	6.8	24.5	120.0	43,800	525,600
609.6	150.0	6.2	24.4	120.0	43,800	569,400
575.0	150.0	6.0	24.6	120.0	43,800	613,200
520.0	143.8	5.8	25.0	115.0	41,989	655,189
470.0	130.0	5.2	25.0	104.0	37,960	693,149
427.5	117.5	4.7	25.0	94.0	34,310	727,459
392.5	106.9	4.3	25.0	85.5	31,214	758,673
362.5	98.1	3.9	25.0	78.5	28,645	787,318
332.5	90.6	3.6	25.0	72.5	26,455	813,773

NOTES: @ At end of year
All gas volumes in MMCF @ 14.4 psia
c High pressure separator gas

Obviously, if we take 150 million cubic feet a day and multiply it by 30 years and some odd days the result will be the figure for the gas in place. Therefore, clear over at the right hand side is shown the line which represents the gas in place inside of that as recoverable reserves for 400 pounds. Now, the area under that 150 million cubic feet line down to the base and from the left clear over to the right, those areas represent gas volume, and for that reason they are pictorial representations of the figures that have been developed. The little zigzag line above the 150 million cubic feet per day line is the actual legal allowable of those number of wells.

Q That is the line which you have designated with the letter "A"?

A That is right. It is explained as legal allowable,. 25 per cent of open flow for those specified number of wells, and it shows as it drops down then another well has to be added to keep it up or from falling below the 150 million cubic feet per day mark.

Q And the dotted line marked with the letter "B"?

A That line is part solid and part dashed. Within the curve and below the 150 million cubic feet per day mark is where the amount of gas that 25 wells can legally deliver at this stage in the depletion of the reservoir. Projecting up and to the left is the legal allowable that 25 wells could produce, would amount to earlier in the life of the reservoir, and extended on down is how much 25 wells can legally produce at the 20-year line.

Q Right. Would you resume the text now then, Mr. Hawthorn,

on page 37.

A

Pendant d'Oreille Field

Deliverability analysis of the Pendant d'Oreille field is projected on the basis of 290 MMMCF of raw gas initially in the reservoir and eight available wells at the start. At a rate of production of 30 MMMCF per day of raw gas or 28.5 MMMCF of net residue sales, the initial eight wells can provide the required delivery for only one year and after that more wells will have to be added as shown on the tabulation and graph. Thirty wells will be required in the fifteenth year to provide the designated delivery and after that it will fall off as shown.

According to this analysis approximately 70 per cent of the gas originally in place can be produced in twenty years with the well program shown. The field is estimated to cover around 58,000 acres so on the basis of thirty wells the drilling density will be approximately one well to each 2,000 acres. Economics would permit more than thirty wells to be drilled if required for proper drainage. An average open flow potential of 16 MMCF per day has been determined from the available data on the present wells. If this productive capacity is maintained in future wells and there is sufficient continuity of the sands to where all of the estimated gas can be withdrawn by the thirty wells, thereby making the deliverability forecast reasonably correct, then it would probably be uneconomical to drill more wells since they would have little effect on prolonging delivery capacity or the amount of gas recoverable over the twenty year period. If thirty wells were to be available at commencement

of production the legal allowable would be as shown by the dashed line on the graph and in the earlier years the daily open flow capacity would be several times more than the 30 MMCF per day used in the calculations. However, if gas is withdrawn at a faster rate, the reservoir pressure will decline correspondingly and the time at which the wells will not produce 30 MMCF per day legally will be reached sooner than shown.

Q Then you have - -

A The graph curve pattern just exactly as the one just described.

DELIVERABILITY CALCULATIONS
PENDENT d'OREILLE FIELD

1 Year	2 Yearly Raw Gas Production	3 Remaining Raw Gas M	4 Average Pressure psia M	5 Average Potential per well M	6 Producing wells
Initial		290,000	748	16.0	8
1	10,950	279,050	720	14.9	9
2	10,950	268,100	692	13.9	9
3	10,950	257,150	663	12.9	10
4	10,950	246,200	635	12.0	10
5	10,950	235,250	607	11.1	11
6	10,950	224,300	579	10.2	12
7	10,950	213,350	550	9.4	13
8	10,950	202,400	522	8.6	14
9	10,950	191,450	494	7.9	16
10	10,950	180,500	466	7.2	17
11	10,950	169,550	437	6.4	19
12	10,950	158,600	409	5.7	22
13	10,950	147,650	381	5.1	24
14	10,950	136,700	353	4.5	27
15	10,950	125,750	324	3.9	30
16	10,676	115,074	297	3.3	30
17	9,034	106,040	274	2.9	30
18	7,939	98,101	253	2.5	30
19	6,844	91,257	235	2.2	30
20	6,022	85,235	220	2.0	30

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DELIVERABILITY CALCULATIONS
PENDANT d'OREILLE FIELD cont'd.

7	8	9	10	11	12	13
Total A	Daily Raw Gas Production			Net Residue Gas Sales @ 95%		
Potential	Total	Avg/Well	% of Pot.	Daily	Yearly	Cumulative
128.0						
134.1	30.00	3.33	23.4	28.5	10,402	10,402
125.1	30.00	3.33	22.4	28.5	10,402	20,804
129.0	30.00	3.00	24.0	28.5	10,402	31,206
120.0	30.00	3.00	23.3	28.5	10,402	41,608
122.1	30.00	2.72	25.0	28.5	10,402	52,010
122.4	30.00	2.50	24.6	28.5	10,402	62,412
122.2	30.00	2.31	24.5	28.5	10,402	72,814
120.4	30.00	2.14	24.5	28.5	10,402	83,216
126.4	30.00	1.87	24.9	28.5	10,402	93,618
122.4	30.00	1.76	23.9	28.5	10,402	104,020
121.6	30.00	1.58	24.5	28.5	10,402	114,442
125.4	30.00	1.36	24.7	28.5	10,402	124,824
122.4	30.00	1.25	23.9	28.5	10,402	135,226
121.5	30.00	1.11	24.5	28.5	10,402	145,628
117.0	30.00	1.00	24.7	28.5	10,402	156,030
99.0	29.25	.98	25.0	27.8	10,142	166,172
87.0	24.75	.82	25.0	23.5	8,582	174,754
75.0	21.75	.72	25.0	20.7	7,542	182,296
66.0	18.75	.63	25.0	17.8	6,502	188,798
60.0	16.50	.55	25.0	15.7	5,721	194,519

NOTES: A At end of year
All gas volumes in MMCF @ 14.4 psia

Q Go on then to page 39.

A Manyberries Field

As seen from the accompanying tabulation, the deliverability analysis of the Manyberries Field has been carried out on the basis of an estimated 34 MMMCF of raw gas initially in place in the reservoir. Three wells are now completed in the field which have an average potential of 24 MMCF per day per well. If the field is produced at a rate of 4 MMCF per day, the present three wells will be able to deliver the gas for thirteen years, after which more wells will be required.

The projection shows that if eight wells are ultimately drilled in the field, the delivery rate of 4 MMCF per day can be maintained for eighteen years before reaching the legal

allowable of twenty-five per cent of open flow capacity. There is enough gas reserve in the field and the field covers a sufficient number of acres to justify eight wells. However, the deliverability graph shows that only a little more gas can be recovered after the fifteenth or sixteenth year by the drilling of three or four more wells. The calculations indicate that four wells can maintain the delivery rate of 4 MMCF per day for fifteen years, and five wells for sixteen years. Unless the performance of the field, as it produces, shows the lack of proper connection between sands and sand-lenses, resulting in poor drainage characteristics, there will be no need to drill the entire eight wells.

As seen from the graph the present three wells can provide a much higher rate of daily withdrawal for the first few years of production than the 4 MMCF per day that has been used. If the cumulative annual production, however, exceeds that which has been used in the calculations, the reservoir pressure will decline more rapidly and the twenty-five per cent allowable will be reached at an earlier time.

David G. Hawthorn - Dir. Ex.

DELIVERABILITY CALCULATIONS
MANYBERRIES FIELD

1 Year	2 Yearly Raw Gas Production	3 Remaining Raw Gas At	4 Average Pressure psia At	5 Average Potential per well At	6 Producing Wells
Initial		34,000	895	24.0	3
1	1,460	32,540	857	22.3	3
2	1,460	31,080	818	20.7	3
3	1,460	29,620	780	19.1	3
4	1,460	28.160	741	17.5	3
5	1,460	26,700	703	16.0	3
6	1,460	25,240	664	14.6	3
7	1,460	23,780	626	13.2	3
8	1,460	22,320	588	11.8	3
9	1,460	20,860	549	10.5	3
10	1,460	19,400	511	9.3	3
11	1,460	17,940	472	8.1	3
12	1,460	16,480	434	7.0	3
13	1,460	15,020	395	6.0	3
14	1,460	13,560	357	5.1	4
15	1,460	12,100	319	4.2	4
16	1,460	10,640	280	3.4	5
17	1,460	9,180	242	2.6	7
18	1,460	7,720	203	1.9	8
19	1,387	6,333	167	1.4	8
20	1,022	5,311	140	1.0	8

7 Total At Potential	8 Daily Raw Gas Production Total	9 Avg/Well	10 % of Pot.	11 Net Residue Gas Sales @ 95% Daily	12 Yearly	13 Cumulative
72.0						
66.9	4.0	1.30	5.55	3.80	1,387	1,387
62.1	4.0	1.30	5.98	3.80	1,387	2,774
57.3	4.0	1.30	6.44	3.80	1,387	4,161
52.5	4.0	1.30	6.98	3.80	1,387	5,548
48.0	4.0	1.30	7.62	3.80	1,387	6,935
43.8	4.0	1.30	8.33	3.80	1,387	8,322
39.6	4.0	1.30	9.13	3.80	1,387	9,709
35.4	4.0	1.30	10.10	3.80	1,387	11,096
31.5	4.0	1.30	11.30	3.80	1,387	12,483
27.9	4.0	1.30	12.70	3.80	1,387	13,870
24.3	4.0	1.30	14.33	3.80	1,387	15,257
21.0	4.0	1.30	16.45	3.80	1,387	16,644
18.0	4.0	1.30	19.04	3.80	1.387	18,031
20.4	4.0	1.00	22.21	3.80	1,387	19,418
16.8	4.0	1.00	19.60	3.80	1,387	20,805
17.0	4.0	.80	23.80	3.80	1,387	22,192
18.2	4.0	.57	22.50	3.80	1,387	23,579
15.2	4.0	.50	21.96	3.80	1,387	24,966
11.2	3.8	.48	25.00	3.61	1,318	26,284
8.0	2.8	.38	25.00	2.66	971	27,255

NOTES: At end of year
All gas volumes in MMCF @ 14.4 psia

Q Thanks very much. The last portion, sir, is to be presented by Dr. Sanderson.

THE CHAIRMAN: I was wondering if we would have sufficient time to allow Mr. Fenerty to ask his three minutes of questions.

MR. MARTLAND: I would doubt if there is, to permit both, sir.

THE CHAIRMAN: Well, possibly if you do not mind, we will have Mr. Lewis back.

MR. FENERTY: I think I have heard sufficient in this last evidence to emphasize the point I wished to make without asking my friend any questions. I think it has been dealt with as much as I need.

THE CHAIRMAN: All right, that is fine.

DR. JAMES O.G. SANDERSON,

having been first duly sworn, examined by Mr. Martland, testified as follows:

Q Dr. Sanderson, would you please outline briefly your qualifications?

THE CHAIRMAN: The Board knows Dr. Sanderson and I do not think it is necessary.

Q MR. MARTLAND: Thank you, sir. You have prepared that portion of the report, Dr. Sanderson, which is entitled "Discussion of the Prospects of Future Discovery of Oil and Gas in Several Natural Subdivisions of The Province of Alberta"?

A That is correct, sir.

Q Would you please proceed to read that portion?

Dr. J.O.G. Sanderson - Dir. Ex.

DISCUSSION OF THE PROSPECTS OF FUTURE DISCOVERY OF OIL AND GAS IN SEVERAL NATURAL SUBDIVISIONS OF THE PROVINCE OF ALBERTA.

by

Dr. J. O. G. Sanderson.

Introduction

In considering the prospects for the discovery of further gas and oil fields in Alberta it is convenient to discuss the features and prospects of the several natural subdivisions of the province separately. These subdivisions of the southern portion of the province are based essentially on the distinguishable and distinct structural geological features of each subdivision. They have been outlined and are shown on the accompanying map, entitled "Prospective Gas Provinces". That map accompanies the next page. The Areas are named for the purposes of the present discussion as follows:

Eastern Basin belt
Moose Jaw Basin (Sask.)
Sweet Grass Arch
Rocky Mountain belt
Foothills belt
Central Basin belt

For practical purposes the portion of Alberta that is discussed in the present instance is that part lying south of 57° North Latitude. Areas north of that boundary are too remote to warrant consideration at this time.

The Foothills belt, Central Basin area, and Eastern Basin belt each extends beyond Alberta into east central and northern British Columbia and into the Northwest Territories, and the Eastern Basin belt extends into western Saskatchewan. Production obtained from them will seek

the same market outlets that are set up to serve the Alberta areas.

The Central Basin belt has been comparatively little explored by drilling, except at the extreme south end, and there is little significant well information with respect to subsurface conditions available. This must be interpreted from well information that is available on either side. The prospects of gas and oil discoveries in this belt will be considered last. The belts I have mentioned are outlined on this map.

The Rocky Mountain Belt

This is a relatively narrow belt running along the southwest boundary of the province. It is limited on the southwest by the Alberta-British Columbia boundary line and on the northeast by the outermost limits of the faulted and folded exposures of Palaeozoic formations that comprise the Rocky Mountain system.

The prospects of the discovery of gas or oil fields of commercial importance in this belt are considered to be negligible.

The Foothills Belt

The Foothills belt fronts the Rocky Mountains from Montana, across western Alberta into British Columbia. It extends outward to the most northeasterly thrust faults which lie approximately over the deepest parts of the Alberta syncline.

The Foothills belt is intricately faulted and folded. The surface rocks are Cretaceous and younger in age, but are

Dr. J.O.G. Sanderson - Dir. Ex.

Princess-Medicine Hat area for a distance of some 500 miles. The southeastern portion extends into the province of Saskatchewan, and the southern part of the belt is bounded by the Sweet Grass Arch and Moose Jaw Basin area.

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The Eastern Basin Belt is under the most active exploration at the present time. It includes an area of over 100,000 square miles all underlain by Cretaceous and Devonian sediments, and in part is underlain by formations of intervening ages.

This area includes the most important proved Cretaceous gas field, Viking-Kinsella, and the most promising partly proved field, the Morinville area. It includes also the new and potentially most important area yet found, that at Whitelaw, Alberta, in the Peeace River vicinity. It also includes the most important Devonian oil fields, namely Leduc and Redwater. The former of these includes a very important proved gas reserve.

Virtually all gas and oil accumulations so far discovered have not been caused by true folding but result from:

1. Coral reefs in the Devonian
2. Draping structures over coral reefs
3. Entrapment in the updip portions of sand lenses.

The non-relationship to structural folding will have an important bearing on the frequency, distribution and size of accumulations that exist but which have not been discovered. The lens accumulations can occur anywhere, and every acre of this immense area is possible gas producing territory until tested, even though the contouring appears unfavourable.The uplifted portions, however, are more favourable and are likely to contain gas or oil at more than one horizon whether

the uplift is caused by subjacent reefs or by true folding. Folding, northeast from the marginal thrust fault of the Foothill belt is conspicuously meagre.

Cretaceous Gas: Gas sands occur in the lower parts of the Colorado and Blairmore (Lower Cretaceous) formations of the Cretaceous. The sands in the Colorado formation are thin, but usually extend over large areas, the Viking-Kinsella lens covering some 366,000 acres of productive sand. The gas occurs in the sand lenses where closure has been caused by subjacent Devonian reefs or in the updip ends of the lenses, and perhaps in true structural folds in some cases.

The sand lenses in the Blairmore are much less regular in extent and thickness, but they occur sporadically through one or more zones up to 100 feet thick. TThe commonest occurrences are in zones, of this range of thickness, that occur near the base of the formation and in the eastern part of the area, near the middle of the Blairmore formation. The Blairmore has been a less dependable and much less important source of gas, and it takes much more well drilling to prove up a reserve.

Many wells have been drilled into and through the Cretaceous in the Eastern Basin belt. Besides the large fields a number of small fields have been discovered, some of which may become fields when fully explored. Many wells have reported gas or shows of gas but have not been completed in the Cretaceous, while other wells are believed to have been drilled

through gas sands which have not been reported and in the case of rotary wells have not even been detected. This is partly due to the circumstances that over most of the Eastern Basin belt the formation pressures are subnormal or lower than normal hydrostatic pressure in a well.

The majority of the exploratory wells that have been drilled in this area have found some gas in the Cretaceous; however, much of it is in non-commercial quantities. The evidence indicates that had there been sufficient incentive, more of the exploratory wells would have been completed as gas wells and more shows in isolated wells would have been followed up and new fields developed.

The Cretaceous sands for the most part contain free gas unassociated with oil. To only a minor extent will the recovery of Cretaceous gas be contingent upon oil recovery.

Devonian Oil and Gas: Oil and gas occurs in the higher portions of Devonian coral reefs and in porous Devonian limestones draped over them. These coral reefs grew in a shallow sea with essentially the same conditions over an extraordinarily large area. The same type and age of coralline reefs are found at Norman Wells at the edge of the Arctic circle near Edmonton, in southwestern Saskatchewan, and at various places along the Rocky Mountains from the Arctic circle into Montana.

So far as can be ascertained, conditions were

generally favourable for reef growth in all of the Eastern Basin belt. Commercial production has been found in the Princess field at the southeast end and at Normal Wells beyond the north end. The largest fields have been found near Edmonton where most exploration has been conducted. There is proof of Devonian gas and oil production the full length of the Eastern Basin belt, but not enough exploration has been done to show whether the favourable reefs will be grouped in certain portions of the area, or whether favourable reefs will be found in all parts of the belt.

So far no important gas accumulations have been found that are not associated with oil. Either the gas is in solution in oil or is found as free gas caps in contact with commercial oil accumulations. This association with oil means that the recovery of the gas must be incidental to the recovery of the oil.

The active exploration of the Devonian started within the past six years, and became intensive after the beginning of 1947 when the Leduc pool was found. The Devonian has been far less extensively explored than the Cretaceous.

The general geological conditions now known indicate that a number of fields will likely be found by further drilling exploration. The total of proved, plus probable gas fields so far found is approximately thirty-five. The prospects are that several times as many more will be found.

THE SWEER GRASS ARCH

The Sweet Grass Arch extends from the Montana border northerly to the south portion of the Princess area. It is a broad, plunging fold extending west, north and east from the Sweet Grass Hills in Montana.

Madison, Jurassic and Cretaceous formations are explosed as belts around these hills.

Superimposed on the arch are smaller folds that plunge northerly. The area has a number of gas fields most of which are small. The gas occurs in the Jurassic and Cretaceous, the latter being the more important. Some oil has been found but very little of the gas is associated with the oil. The most important fields are Medicine Hat, Bow Island and the Pendant d'Oreille group of fields.

This area contains the earliest commercial discoveries of gas and oil in Alberta and it has been more thoroughly explored through the Cretaceous than any other large area in Alberta. Doubtless, other Cretaceous gas fields will be found in it, but it is not as promising for additional large discoveries in the Cretaceous as is the Eastern Basin belt.

TThe formations below the Cretaceous have been little explored, except close to the Montana border where they are found at relatively shallow depths. There appear to be prospects between Milk River and Princess for stratigraphic traps in some of the older formations, as well as in Devonian reefs.

MOOSE JAW BASIN AREA (SASKATCHEWAN)

Only a small part of this large regional structural feature lies in Alberta. It is confined mainly to southwestern Saskatchewan and is the northerly extension of a broad basin that dominates the structure of north central and eastern Montana.

The sediments of this basin are closely comparable to those of southeastern Alberta. The probability of the occurrence of important reserves of natural gas in this basin is indicated by the important, proved gas fields north and east of Havre, Montana, and at Bowdoin and on the Baker-Glendive structure.

CENTRAL BASIN AREA

The Central Basin area extends from the West-Peace River area southeastward to the Sweet Grass Arch and the U.S. border.

A number of wells have been drilled in the Central Basin area at the Montana end just north of the Cutbank group of fields, and a few scattered wells in the central portion opposite Turner Valley. Of the latter only about ten wells have reached the Madison. The basin is therefore unexplored. As here defined it covers some 40,000 square miles.

The deepest part of the basin is along its southwest edge under the outermost overthrust faults of the foothills belt. The depth to the base of the Cretaceous is believed to range from 10,000 to 15,000 feet along this zone, but this becomes less

toward the eastern limit of the Central Basin area.

The depth to the Madison, and the generally commercially unattractive nature of the Cretaceous gas occurrences in this belt has in the past provided little incentive to explore the Central Basin area by drilling. It may be expected that until the three other more attractive areas are explored there will be little if any interest in the Central Basin area. Most likely, exploration will proceed step by step down-dip from the northeastern area now under active exploration. Such a step is a well currently being drilled near Chip Lake west of Edmonton, which has recently been reported to have found natural gas and some condensate in the Blairmore. It is unlikely, however, that the Central Basin area will be intensively explored for some years.

Although the Central Basin area has not been penetrated by many wells, the distribution of formations in it can reliably be inferred from what is positively known on either side of it. In the Foothills belt the Mississippian, Cretaceous, Jurassic, and Triassic formations are known to occur. The Madison Limestone is the important reservoir in Turner Valley, Pincher Creek and Jumping Pound, and the Devonian and other Palaeozoic formations outcrop in the front ranges of the Rocky Mountains. The Jurassic, Triassic and Madison formations are absent from most of the Eastern Basin belt. It is apparent that the Cretaceous and Devonian can be expected to extend under all the Central Basin area.

The Cretaceous is thicker and has more sand in it in the Foothills than in the Central Basin area, hence it may be expected that sand conditions will be found better developed, that is, in thicker beds over larger areas and with coarser average grain size, proceeding downdip across the Central Basin area toward the edge of the Foothills belt. It may be expected that where conditions favour accumulation, gas or oil will be found in them.

Folding, where present, will favour accumulation but commercial deposits can be expected in up-dip edges of lenses or over reefs or buried hills in the Madison or other partly eroded formations near their buried, truncated margins.

The Jurassic, Triassic and Madison formations have yielded production of oil and gas at different places in the Foothills belt, on the Sweet Grass Arch and in the Peace River area on the west side of the Eastern Basin belt, (note recent Whitelaw discovery). In areas of the Central Basin belt where these formations occur, the prospects of their holding oil or gas pools are very good. Where these formations are porous and permeable they may act as traps for oil and gas that have migrated from formations lying below them.

The Jurassic, Triassic, and Madison formations were all subjected to erosion before being covered by the Cretaceous deposits. The lines of truncation of the formations occur in various parts of the basin, which can only be determined by drilling. Similar

eroded and buried formations and surfaces have in many places in the United States provided entrapments for important pools of oil and gas. It may be expected that accumulations in such traps exist in the Central Basin area, and truncation traps may extend into the Eastern Basin belt, particularly in the Madison.

The Devonian formations on all sides of the Central Basin area are petroliferous and show evidence of reef structure and reef forming sediments. It cannot be certain that conditions were favourable for reef development in the centre of the Central Basin area but there appears to be no evidence of the presence of conditions unfavourable to the occurrence of reefs. In deeper portions of the Central Basin area the Devonian formations occur at depths that may be prohibitive for natural gas development only.

It is our opinion, inferred from known conditions, that the basin offers good possibilities in at least seven horizons:

Colorado formation

Blairmore formations

Jurassic formations

Triassic formations

Permo-Pennsylvanian formations

Madison formations

Devonian formations

Commercial accumulations if oil and gas can

occur not only where the formations have been structurally folded but as the result of draping over reefs or buried hills, along the truncated margins of formations, in the upper portions or edges of sand lenses, or in coral reefs. The diversity of formations and of conditions for entrapment appear to be promising geologically and to offer attractive prospects for the development of further gas and oil reserves.

The discovery of gas at greater depths such as prevail in the Central Basin area ssured larger gas reserves per acre foot; however, it is unlikely that this area will be intensively explored for some time, but it is a good prospect for production in the more distant future.

NORTHEASTERN LIMIT OF PROSPECTIVE PRODUCTIVE AREA.

The northeastern limit to the area that is deemed to have possibilities of having commercial pools of gas or oil is an isopach contour line. It runs roughly northwest - southeast across the northeast corner of the area shown on the accompanying map, and passes through a point about 70 miles west of Fort McMurray.

This contour line joins the points at which the Palaeozoic and Mesozoic sediments are 1000 feet thick. Its location is largely inferred because it has nct been accurately located by drilling.

It is generally conceded that there are small prospects of finding commercially important pools of gas or oil in a section that is 1000 feet or less in

thickness from the Pre-Cambrian surface to the ground surface.

Q I think that is a convenient time to adjourn, sir.

THE CHAIRMAN: Yes, we will now adjourn.

(Hearing adjourned to September 26th, 1950, at 9.30 A.M.)

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